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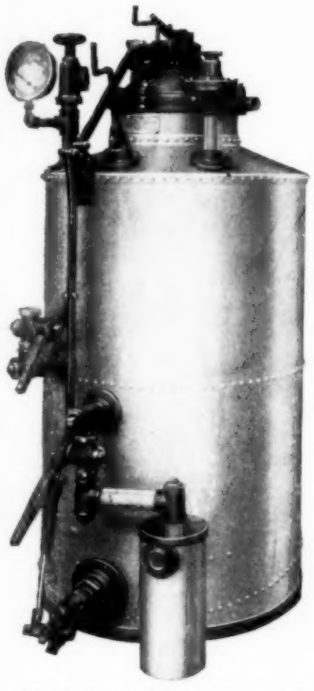

These Generators are used both for stationary and portable installation. It is impossible to employ better material and workmanship than goes into these machines. Note the simplicity and strength.

Oxy-Acetylene Fusion Welding Gives Leadership In Many Lines

"Continuous metal" is, obviously, better than joints or seams, whether brazed, riveted or soldered. It means, simply, a stronger, more durable, more saleable product. Orders, Customers, reputation—the aim and object of business—is won by this advantage. In addition, manufacturing cost is often largely reduced. No industrial improvement could be more important. Ask any Engineer who keeps posted in production methods.

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Goodyear Oxy-Acetylene Equipment

includes everything needed—Acetylene Generator, Oxygen Supply, Hydraulic Back Pressure Valve, Chemical Purifier and Blow Pipes. The entire equipment is scientific in design and of high efficiency. It is the result of over 15 years' experience in Acetylene work, plus exhaustive investigation of both European and American practice in Oxy-Acetylene applications. The Goodyear Pressure Acetylene Generator feeds carbide into water a little at a time. Gas so made is not deteriorated by excessive heat. The generation is cool. Our simplicity is matchless. Practically two parts feed the carbide—positively. Gages of metal used in our construction are heavier than in others, open-hearth steel plates being used. Galvanizing is done after assembling. Steel castings, bronze bushings and heavy steam fittings employed. Generators have positive mechanical interferences which interlock, prohibiting improper handling. Permitted by National Board of Fire Underwriters. Even to the last accessory we make a quality product, and do not compete with the man who has nothing to talk but "price." You would not have it otherwise once you know all the facts.

Gas For Welding Should Be Chemically Purified

Acetylene gas, no matter how generated, contains phosphuretted hydrogen and sulphuretted hydrogen. No welding can be fully successful unless these two impurities are removed from the gas, as is well known by all men conversant with the difficulties of eradicating Phosphorous and Sulphur from high grade Steels and Iron. Many have tried Acetylene welding and given it up because of not knowing these facts. Let us send you our Chemical test. You need it if you have a welding plant.

Write Us

Our success is due to a policy of thoroughness and in rendering efficient service. Let us know your requirements. Printed matter will be sent promptly on request. There is no obligation in writing us fully concerning needs. Address

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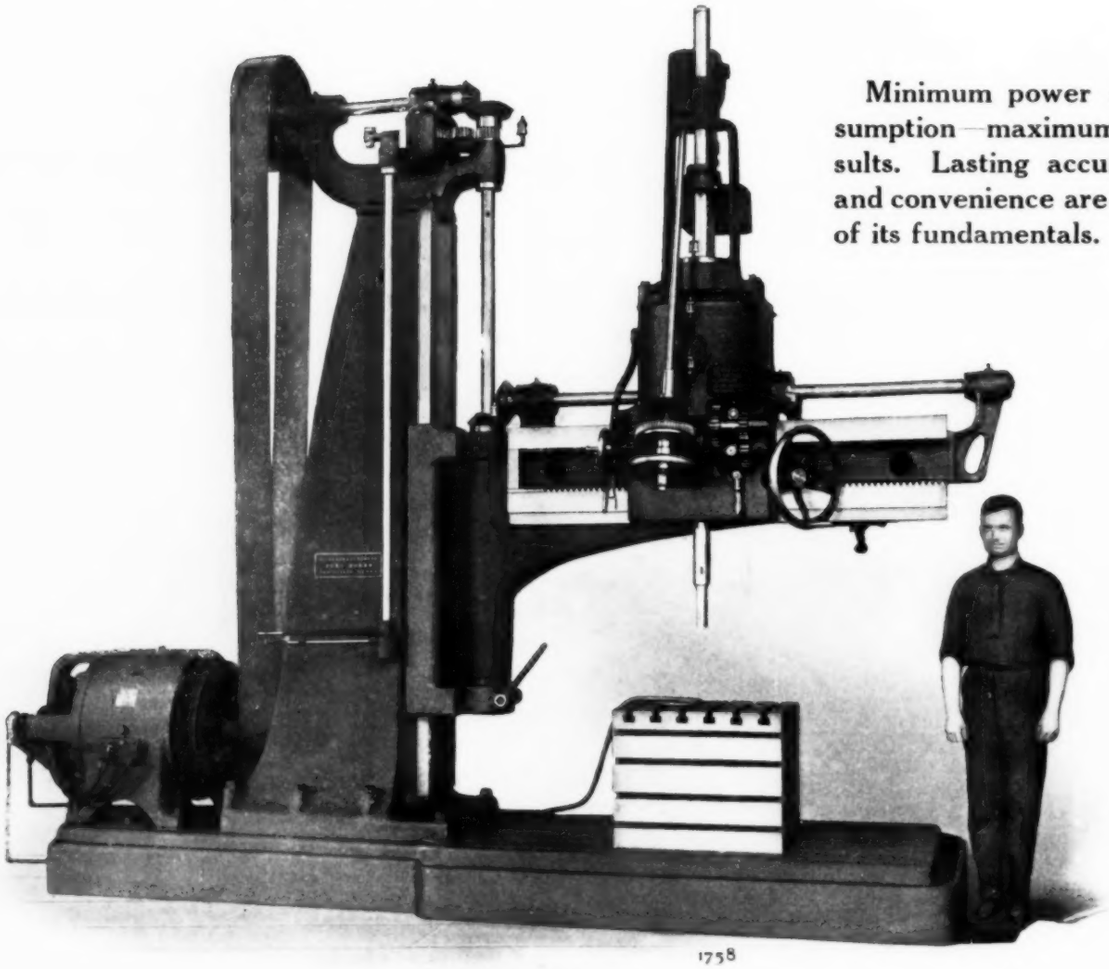
For Output and Reduced Operating Expenses

The Pond Heavy Duty Radial Drill



1758

Minimum power consumption—maximum results. Lasting accuracy and convenience are two of its fundamentals.

All gears steel or bronze. All bearings bronze lined and self oiling.

The machine that meets the extra heavy demands of modern shop practice for continuous heavy duty. *Write for "Progress Reporter" No. 21.*

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(*See pages* 51, 52, 53, 54, 55, 56, 57 *and* 58)

An Unusual Roller Thrust Bearing

By T. F. Salter *

A large thrust bearing for a steel mill, providing roller surfaces for a journal load as well as for a thrust load of over 2,250,000 pounds.

*Engineer, Standard Roller Bearing Company, Philadelphia, Penn.

About three years ago, a Pittsburg steel company designed a machine in which a thrust of 1,500,000 pounds at a speed of 100 revolutions per minute was a feature.

The Standard Roller Bearing Company, who were consulted, designed a bearing of their plain-roller-thrust type, which was installed and has been in service more than two and a half years. A second machine of the same type but in which the thrust load was increased to 2,000,000 pounds has recently been completed, Standard plain-roller thrust bearings being used. This second machine was also fitted with roller journal bearings as well as thrust bearings, thus being equipped with roller bearings throughout. The thrust load is applied hydraulicly. The working load on thrust and journal bearings is shown by diagram, Fig. 2. Since installation of these bearings it has been found necessary to increase the thrust pressure to 2,250,000 pounds and they have proved capable under the increase.

Plain-roller thrust bearings used for this service consist of three major elements:

(1) Threads, consisting of two heat-treated, tempered and accurately ground steel washers or plates.

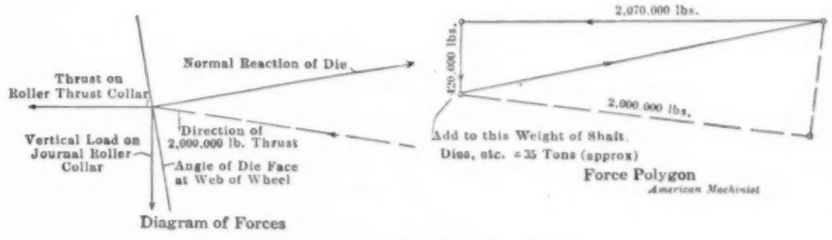

Normal Reaction of Die
Thrust on Roller Thrust Collar
Vertical Load on Journal Roller Collar
Direction of 2,000,000 lb. Thrust
Angle of Die Face at Web of Wheel
Diagram of Forces
2,070,000 lbs.
420,000 lbs.
2,000,000 lbs.
Add to this Weight of Shaft, Dies, etc. =35 Tons (approx)
Force Polygon
American Machinist

FIG. 2. DIAGRAMS OF FORCES ON BEARINGS

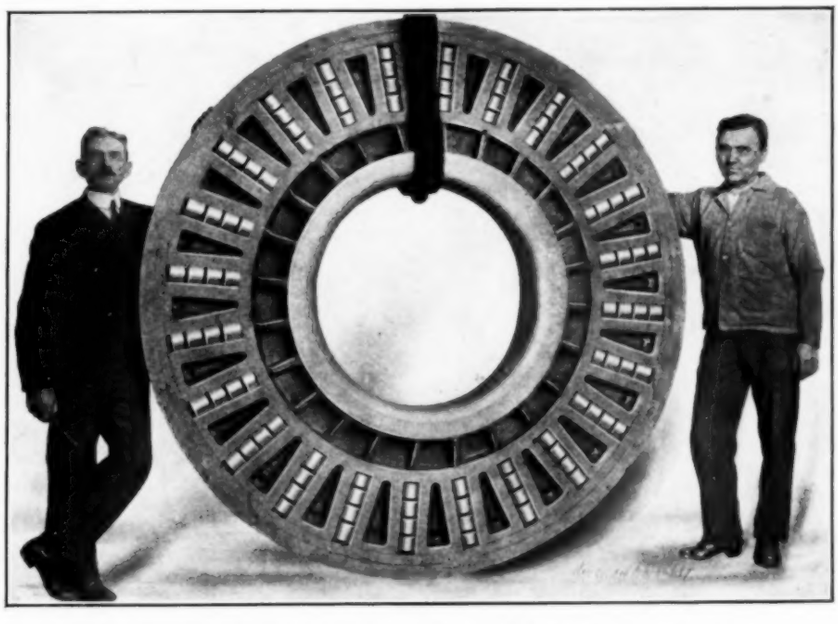


FIG. 1. ROLLER THRUST BEARING FOR 2,250,000 POUNDS LOAD

(2) Roll cage, usually of bronze, complete with rolls of steel, heat-treated, tempered and accurately ground; retaining band, ball thrust, etc., Fig. 1.

(3) Leveling device, consisting of two washers or plates, one face of each being convexed and concaved respectively, thus permitting a ball-and-socket base for the bearing and insuring an equal distribution of the load, even though all parts adjacent be not in exact alinement.

The general dimensions of cage are 2 feet 7 inches inside diameter by 6 feet 5½ inches outside diameter, and details of construction will be found by consulting line drawing, Fig. 3. The bearings shown are inclosed in the casing of the machine, all voids around bearings being packed with grease, and large compression grease cups are provided to supply lubricant as consumed.

The after, or right-hand tread washer was required to be extra thick, to avoid deflection, as it is supported at outer edge only, the forward, or left-hand tread washer is amply supported over its entire face. The plates are made of high-grade, special alloy steel, being forged into form as washers. They are bored, turned and faced to approximate dimensions, allowances being made for grinding. Washers are then subjected to heat treatment, are hardened, drawn, and then carefully ground to very close limits, the two faces being as nearly parallel as human ingenuity and highest-grade grinding machinery can produce, each face being in itself perfectly level and parallel.

Thrust cages are of phosphor bronze, carefully machined, special care being exercised in the location of the slots which carry the rollers. The rollers are manufactured from a high-grade, special alloy steel, carefully heat treated, and all rollers are ground true cylinders, the error in parallelity for a given roll and diameter of all rolls in the bearing being held within 0.0002 inch, plus or minus, of the nominal diameter. Heavy steel retaining bands are provided which encircle the bronze cage and retain the rollers in their respective slots, a steel ball being provided at the end of each roll slot to care for the end thrust of the rolls in the slot, due to centrifugal force and that force generated by reason of the rolls being guided by the cage in a circular path, instead of their natural tangential path.

The journal bearings, Fig. 4, are 3 feet 4 inches internal or shaft diameter, 4 feet external diameter, equipped with 4-inch diameter rolls, the cage being 1 foot 1 inch long overall. The cage is made of phosphor bronze, machined all over, rollers being set in machined pockets in cage where they are confined by a steel ball which fits into a pocket or recess bored in the ends of each roll, the ball being inserted from ends of cage and held in place by heavy follower screw.

Designers or engineers inspecting the halftones and drawing of this thrust bearing will at once note the apparent opposition to theory in its design and construction. In other words, it would seem

that tapered rollers whose faces would converge at the center of rotation should be used, instead of the cylindrical or parallel rollers which have been used.

The desirability of using taper rollers is well understood, but the difficulties of manufacture from a commercial standpoint have made the use of tapered roller bearings undesirable. A series of tapered rollers such as would be required for a given bearing can be made uniform only through excessive care; in fact, skill required to produce a series of rollers, all of approximately uniform dimensions, is found only at rare intervals and as a practical proposition is quite out of the question. To be satisfactory, each and every roller in a tapered-roller thrust bearing should be exactly the same diameter at the large end, the same diameter at the small end and exactly the same length, as a variation of a sixty-fourth of an inch in the length would, if diameters of ends were kept true, materially alter the angle of face. On the other hand, if length is exact with one end of roller true to diameter and the other end of roller 0.001 inch plus or minus exact diameter, the load on this roller would be borne by either one end or the other, and not along its entire face.

If some three or four rollers all contained in the bearing are 0.001 inch greater in diameter than their fellows, such large rolls would be forced to bear all the load, the balance of rollers being entirely relieved. It is, further, excessively difficult and impractical to grind the two plates of the given bearing to exactly the same angles and the success of a roller bearing depends entirely upon all bearing surfaces of both rollers and plates being absolutely exact. In the case of the plain-roller thrust bearings, it is comparatively easy to make each roller an exact duplicate of its neighbor, as is also the grinding of plates with faces exactly parallel.

It has been found by comparative tests of roller bearings with cylindrical rolls, and roller bearings with tapered rolls, that the former were more efficient, and that when the test was carried to a breakdown under a given speed, the plain-roller bearing did not show distress until its load had been made considerably in excess of that which resulted in a failure

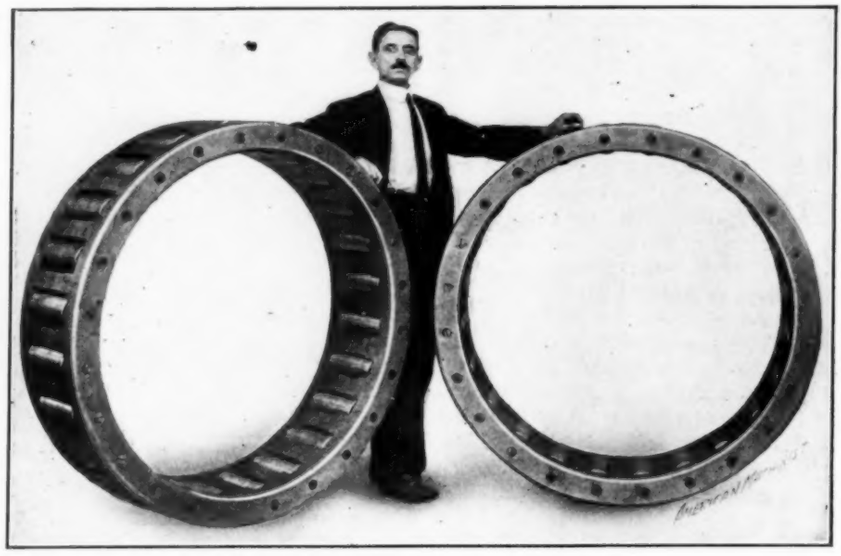


FIG. 4. ROLLER JOURNAL ELEMENT

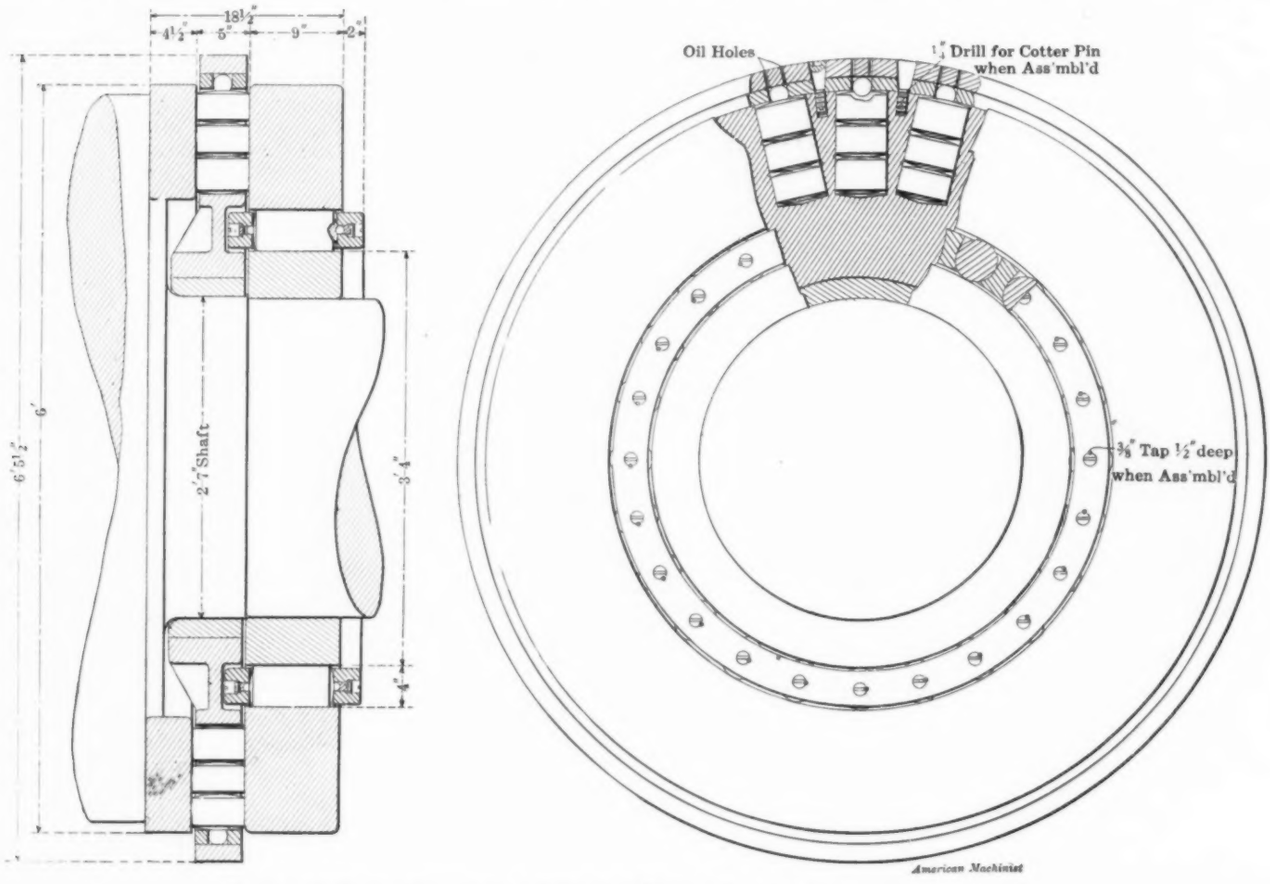


FIG. 3. GENERAL ASSEMBLY OF COMBINED ROLLER THRUST AND JOURNAL BEARING

of the bearing equipped with tapered rollers. Cutting up the cylindrical rollers into short lengths practically eliminates sliding.

Hundreds of thousands of thrust bearings of the plain-roller type are in use, operating under comparatively small loads at several thousand revolutions per minute, and in the larger sizes they have shown their absolute dependability under heavy loads, being extensively used on heavy vertical machinery, such as frequency changers, rotary transformers, hydroelectric generating units, plate-glass polishing tables and similar devices.

Human Nature and Praise in the Shop

By Entropy

Important shop questions discussed. Influence of vacations and some comments on the various effects of praise on different people.

Advantages of giving men the kind of work they like.

When you turn a piece of cast iron three inches in diameter you can measure it and tell within a fraction of a thousandth what size it is. Measure it again in a month and it is liable to be about the same size but it may be crooked. If it is, it is a bit bothersome; but when you get a little matter like that in comparison with the variability of men it is a pretty dead snap after all. Every time you turn around you find a man that must be handled in a different way.

You would think, and many people have not yet gotten over the idea, that workmen would need jobs badly enough so that they would be glad to accept uniform treatment. They will accept it for brief intervals, but it pays to study each one and treat him as an individual.

Men who work by the hour change jobs on very little provocation. I have had men go for one cent an hour raise in pay who could have made themselves worth 10 cents an hour more to me by merely waking up. I have had men leave to get a vacation.

Getting and Giving Vacations

I ran the shop for 10 years without giving anyone a vacation except I was held up for it. My men got vacations just the same. They worked along till they wanted a vacation, then they hunted around for a new job, told the other fellow that they wanted to work out a two weeks' notice, came back and jacked up their job, drew their pay and went off to the seashore and lived like nabobs. They do it all over the country except in shops where they shut down for a fortnight each year.

Some men can go longer without vacations than others but they continue to get about what they want. If their wants are a trifle anticipated they appreciate it. If you handle them right there is about a 50 per cent. dividend right there. It is the "easiest profit" there is if you know how, and the hardest if you don't.

The Influence of Praise

They have a foreman over at Rushem & Pushem's that just about knows the game. He has an idea of what constitutes a day's work that is about the usual thing multiplied by two. He will give a man all the help he can toward doing work the easy way and he will plaster him over with blarney a foot deep if he does the trick, but woe unto him unless he is deaf if he does not. When I first knew of him I thought he would get the men demoralized by too general praise, but I found after a time that he was only bestowing praise where it was due and that he was seeing to it that it was due in most cases.

A man over in that shop knows by the time he has been there a week that if he does not get praise by the yard he is due to go out on the dump. The taffy is a good investment.

Of course, you and I do not feed much on praise but most of the rest of the world will go further for 50 cents worth of appreciation than they will for a dollar in cash.

We look on a celebrated actress' press agent as a sort of a scheme for hoodwinking the public, while it is really a scheme of her manager's to keep her keyed up to her best work.

Suppose you expected to see in tomorrow morning's *Argus* the following item: "Yesterday forenoon John J. Smith of the Beatem Machine Company's shop broke all previous records for turning 4¼-inch pistons by ⅗ of a second. Official notification of the new record, attested by the manager and department foreman, have been forwarded to the Secretary of the International Brotherhood of Gas Engine Piston Turners and it is confidently expected that official action will be taken to place this record in their books."

Imagine this in your local paper with a two-column heading and reprinted in New York, Chicago and Boston in smaller type. Wouldn't you be right on the jump to take off another fifth of a second? That is, all except just you and me who are proof against newspaper or any other kind of praise.

Then we have a fellow right out here in our shop that we had just about given up as a hopeless case until we found that he was our strong man. Now we give him a lathe, two of them in fact, by request, where there is no crane and we give him heavy stuff to handle, something that we go to him with in an apologetic sort of way and say, "See here, Dick, we have got to get those shafts turned and all the lathes out under the crane are busy. We'll get you a couple of helpers to put them in for you." He tells us where to send the helpers, and puts them in himself and just takes delight in getting stock off those shafts so hot it burns the floor. I suspect that a little extra praise will get him to running another lathe.

Then we have another man who is all right if we keep him on the odds and ends of jobs, but if we put him on where he has a dozen of a kind to make he spoils the last three. Give him a new job and tell him you doubt if it can be done and he will do it, and do it right, and do it quickly.

I had a chap of that kind in the blacksmith shop once. He could do a good job of any kind whenever the mood took him. He made a pair of tongs once only an inch and a half long. He did the whole thing blacksmith fashion too, punched out the eye and the rivet hole hot. If I gave him a chain to put a link in it came out just right, but if I gave him a half a dozen bolts to make, the heads all came with cold shuts and off square and all thicknesses. He needed a job in an experimental station not a blacksmith shop.

Advantage of Selecting Work

I believe that one of the largest advantages of a large shop is that you can have men who can do certain things and you can have enough work so that each man can be kept busy at what he likes best, which is synonymous with what he does best.

One of these days I am hoping to see a machine shop with everyone working on something that he is so interested in that we will have to send the watchman around to get them to go home at night. It will be just play for them. It will be more than play to run the shop; it will be heaven. And we can afford to pay that picked gang wages that will make a college professor green with envy.

According to *The Automobile*, $160,000,000 worth of machine tools are now being utilized in the automobile industry which required 43,000,000 man-days to build.

Making Electric Fan Motors

Editorial Correspondence

Some of the machines, tools and operations used in manufacturing electric fan motors.

How the various parts are machined with the use of special tools, jigs and fixtures.

Accuracy in all operations the important feature.

The electric fan is looked upon as an appliance that takes care of itself, is always ready to use when wanted and needs practically no care or attention. There is considerable truth in these suppositions, but the average person has little idea of the refinement in manufacture, the accuracy with which the parts are made and the special tools that are employed, all of which makes a well constructed electric fan practically "fool proof." Through the courtesy of the General Electric Company, Pittsfield, Mass., we are enabled to show some of the machines and tools used in manufacturing their electric fan motor.

The department is complete in itself, makes all of the parts of the fan, finishes, assembles, tests and inspects. The use of jigs, fixtures, automatic machines and special machines has been developed to a great extent.

Fig. 1 shows the set up on a Potter & Johnston semi-automatic chucking machine for finishing the cast-iron motor frame. Here the hole for the bearing is drilled and reamed, slots for the field coils finished and the front end finished in order to receive the head. When we consider that the bearings for the armature shafts are rigid, one being carried in this frame and the other in the head, it will be seen that the hole in the frame into which the bronze bearing is forced and the rim against which the head is fastened, must be concentric. Detailed mention of the outfit of tools is unnecessary. But the location of the controller for the individual motor driving the machine is of interest. It is located back of the headstock and is operated by a long rod ending in a vertical handle seen at the extreme left of the illustration.

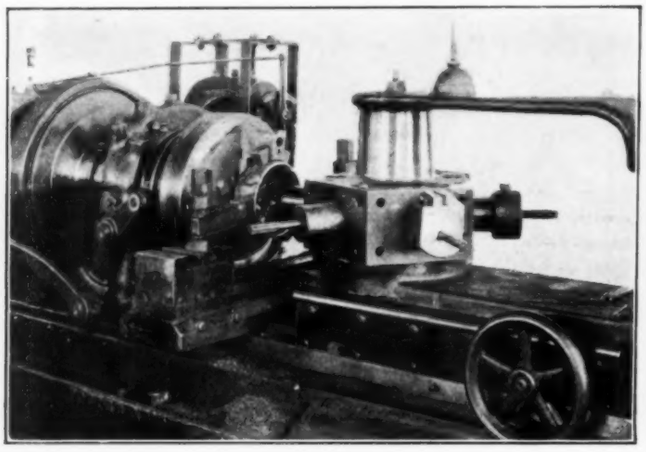


FIG. 1. MACHINING A FAN MOTOR FRAME

ARRANGEMENT OF THE CHUCKING MACHINES

Fig. 2 is introduced in order to show the arrangement of three Potter & Johnston machines around three sides of a hollow square in order that they may be attended by one operator. Each machine is driven by its own motor which permits of this arrangement. A large pile of fan-motor-frame castings is seen within the hollow square. The machine in the foreground has its motor controller in a different position from the one illustrated in Fig. 1, namely, it is placed lower than the headstock and is controlled by a lever running through to the front of the machine, and past the end of the bed. As a matter of interest, all of the larger machines and many of the smaller machines in this fan-motor department are driven by individual motors.

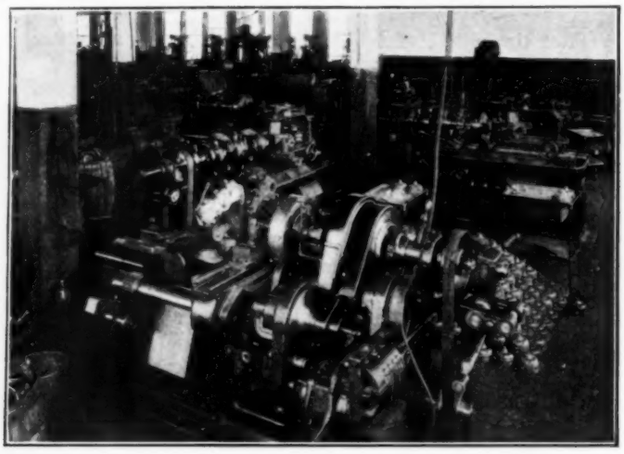


FIG. 2. ARRANGEMENT OF POTTER AND JOHNSTON MACHINES

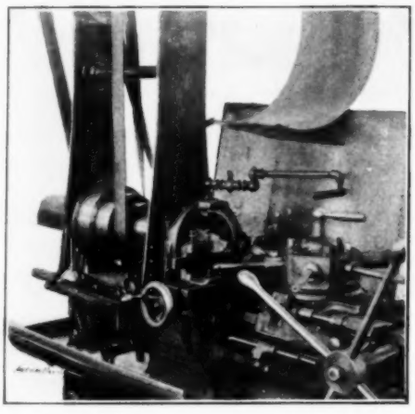


FIG. 3. MACHINING A BRACKET

MACHINING THE BRACKETS

Turning now to Fig. 3, we see a special chuck and set up of tools for machining the fan-motor brackets. The illustration is so plain that very little explanation is necessary. Here the main hole in the bracket is drilled, reamed and the end of the hub faced.

THE FAN MOTOR ARMATURE

The fan motor armature core is built up of laminated disks differing for the alternate-current and direct-current motors. The one seen in Fig. 4 is of the squirrel-cage type. The shaft is forced into place and the rings into which the armature bars are riveted are silver plated in order to insure excellent electrical contact. In order to establish the accuracy of the fit of the armature both the journals and the body size are ground after assembling, see Fig. 4.

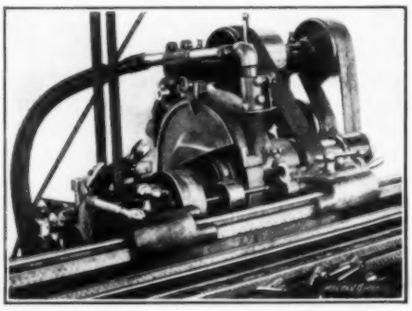


FIG. 4. GRINDING THE ARMATURE SHAFT

Corresponding with this, the bushing that forms the shaft bearings are ground on the external diameter on an arbor in order to insure that the hole and outside shall be concentric and that a proper allowance shall be left for a pressing fit

in the motor frame and head.

There are, of course, many other parts of the fan motor that have not been illustrated or touched upon here, but sufficient has been shown to indicate the refinement with which all of the parts of the fan motors are made. These small machines are in the class of accurate interchangeable machine work.

One room in this department is set aside for japanning. Here all of the finishes of the various parts are put on. The room is amply equipped with dipping tanks, drying racks, baking ovens and the like, thus carrying out the statements that this department is complete in itself and carries on the operations and processes for making the electric fan complete.

Our final halftone, Fig. 5, shows some of the testing benches. Here the motors are brought after assembling and here each motor is given a careful running in prior to shipment in order to know that it is right.

FIG. 5. TESTING ELECTRIC FANS

A Handy Boring Tool

By John Melville

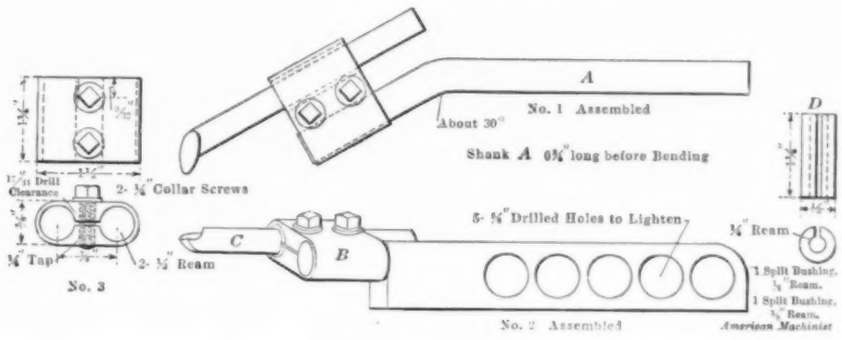
Details of a boring tool with which very good results have been accomplished.

A design that makes it useful for many kinds of work.

The sketch shows a boring tool which I have used for two years now, and it has filled every demand.

I made it for a 14-inch lathe, and for the experimental, model or tool department it is very useful. The smallest hole I can remember boring with it was 0.12 inch, but that is small for a 14-inch lathe, and it will bore anything else up to the capacity of the machine.

From the sketch it will be seen that there are four parts: Shank *A*, holder *B*, tool *C*, and bushing *D*.



A HANDY BORING TOOL

I hunted round the shop till I found an old forged boring tool which was 1x2 inches and in decent condition. I cut off all but 1¼ inches of the forged end, then located it in the chuck and turned the end to ½ inch diameter and just 1¼ inches long. It was then bent to about 30 degrees one inch back from the shoulder, and the five ⅝ holes drilled as shown, to lighten it. A file and some emery cloth finished shank *A*.

Holder *B* was made from a piece of steel that measured 1½x1¼x⅝ inch. I drilled and reamed two ½-inch holes as shown, and then taking the blade out of my hacksaw, I put the blade through one of the holes, fastened the frame and saw together again and sawed through from one hole to the other. The ¼-inch tap holes were then put in with body clearance through one-half of the holder, and the ends of the holder were rounded so that the wall half way round each of the holes was of uniform thickness.

With two collar screws in place, the tool can be used with half-inch bars, but the user will need two split bushings as shown, one reamed out to ¼ inch and the other ⅜ inch so that ¼-, ⅜- or ½-inch drill rod may be used for boring tools. The sketch shows the ⅜ bushing in place in the tool.

Don't make the mistake a friend of mine made: He tried to harden and temper the holder. It is not necessary and means disaster nine times out of ten, because the holder is sure to warp outward from the slot, which means the half-inch holes will be large and you might just as well make a new holder.

When the shank has been clamped in the tool part of the lathe, slack up on the collar screws and you can swing the holder on the turned portion of *A*. The distance between the two half-inch holes is ⅞ inch, so that the tool can be swung ⅞ inch either up or down and the bar is always parallel with the lathe. When it is set to right hight, turn the boring tool *C* for right clearance, then tighten up easily on the collar screws.

In the *Scientific American* Dr. Paul Heroult, of electric furnace fame, is given as the authority for the statement that gases contained in the molten steel are harmless, since they do not produce blowholes. The latter, according to this authority, are the result of disengagement of carbon dioxide, which takes place during solidification as the result of interaction of carbon and iron peroxide. Hydrogen, nitrogen and other gases are harmless, and are to be found in about the same amount in bessemer, basic, acid, open-hearth, crucible, and electric steel.

The Watt Relics at South Kensington

By F. A. Halsey

To an American who realizes the small number of relics which we have of the pioneers in engineering and machine construction, nothing can be more gratifying than to witness the industry and care with which such things have been collected and preserved in England. Of all those whose work we would most wish to have thus cared for, James Watt easily heads the list, and it is precisely his work of which the greatest number of examples remain. It is impossible to overestimate the importance of his work, which constantly grows on one with study. Mr. Chubb has given an account of such things as are kept at Watt's old home and place of business at Soho, and this article will show a few of those which are on view at South Kensington Museum. The man who fails to feel the impulse to uncover his head when standing before these things, deserves expulsion from the fraternity of the machine shop.

A micrometer caliper, surface condenser, steam-engine indicator, trussed beams, gearing to replace the engine crank, models showing application of engine power, and several complete and operative engines are some of the relics that have been preserved with such intelligent care.

These form a striking demonstration of Watt's ability as a machinist, engineer and experimental investigator. The importance of his work cannot be overestimated.

Two Complete Watt Engines

Of these exhibits, the most striking are two complete and perfect examples of engines as built by Watt. The first is illustrated in Fig. 1, which shows his first sun-and-planet engine built in 1788. Its cylinder is 17 inches diameter by 48-inch stroke, the mortise flywheel being 16 feet in diameter. It was nominally of 10 horsepower, but actually indicated 13¼ horsepower, figures which by their smallness are certainly striking in comparison with the size of the machine. It continued at work until 1858, its work being the driving of a metal-working shop of some sort.

The engine illustrates the natural process of transition from the pumping engines previously built by Watt, to engines for driving revolving shafts. The pumping engine, of course, had no shaft, the piston rod being connected to one end of the walking beam, while the pump rod was connected to the other, and the na-

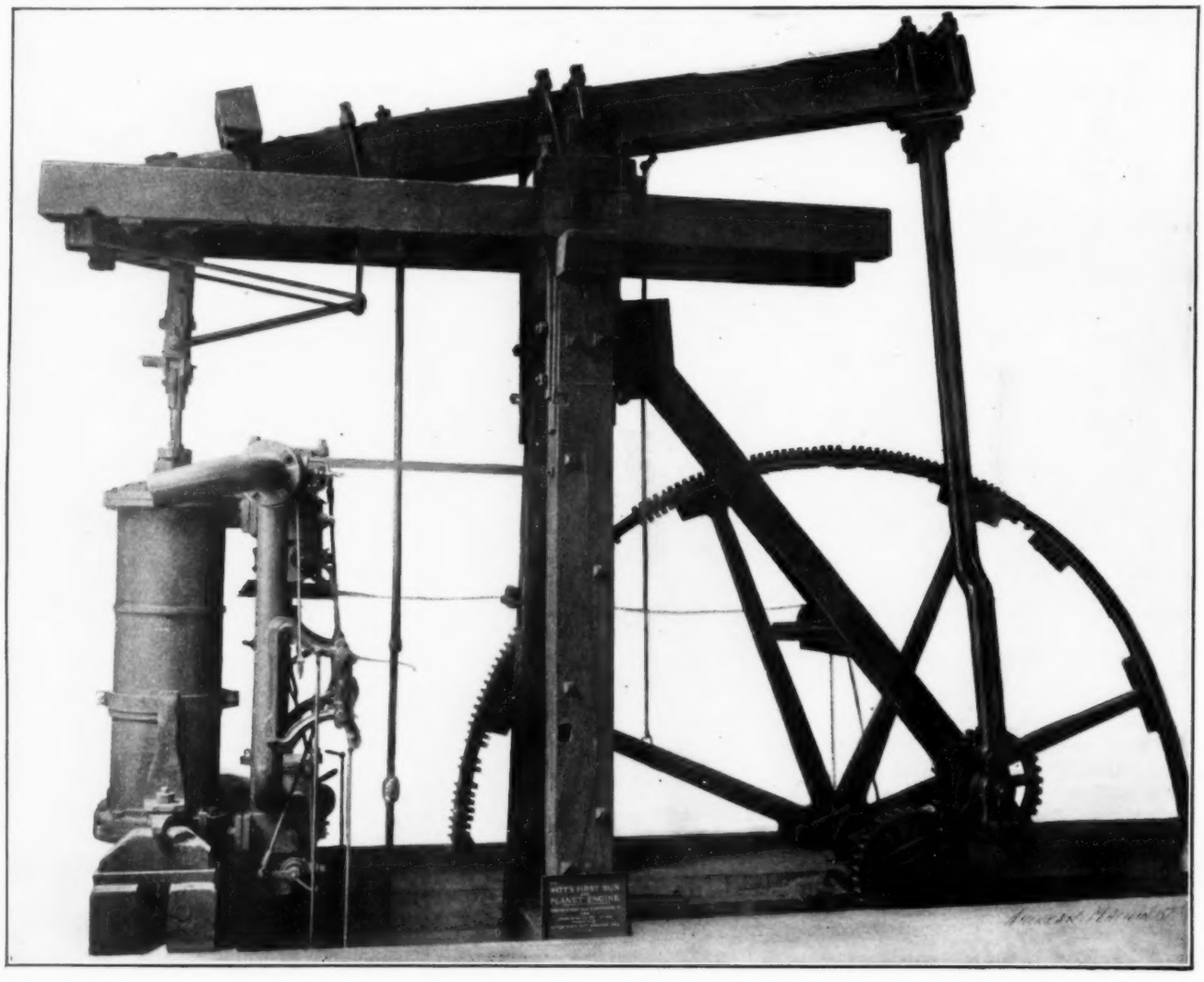


Fig. 1. James Watt's First Sun and Planet Engine—1788

tural method of actuating the valve gear was by a plug rod which hung from the beam, on which suitable tappets moved the valves at the ends of the stroke. In this engine we see precisely the same gear, the plug rod serving also as the air-pump rod, the driving of the valves by means of an eccentric being still unknown. This valve gear, as will be seen, is by no means simple, and the understanding of it in all of its details is not easy without turning over the engine, which is, of course, not practicable. It is, however, clear that the direct action of the tappet was to move the valve to the closed position where it was secured by a latch, the opposite valve being simultaneously opened by the releasing of its latch and the action of a weight. The valves are of the oscillating type, although the exact construction cannot be made out without removing the chest cover. Except for the reversed action, it would require no great stretch of the imagination to see in this an anticipation of the Corliss gear. Moreover, it is a principle of the patent office that reversal of a mechanism does not constitute invention. The governor will be seen behind the valve connections driven by a chain and pulleys. It acts upon a throttle valve of the disk type. We see also Watt's beautiful parallel motion.

Fig. 2 shows another engine in the same collection, which was erected in 1797 and continued in operation until 1885. It had originally a cylinder of 16 inches diameter by 48-inch stroke, but in 1806 the makers substituted a new cylinder of 19¼ inches diameter.

The Progress of Improvement

In several respects this engine is a marked advance over the preceding one. The valves are driven by a crank motion obtained from a lay shaft geared to the main shaft in such manner as to reduce the speed one-half, this being necessary because with the sun-and-planet gear the shaft made two revolutions for each double stroke of the engine. The action of this crank was, of course, the same as that of an eccentric and, in view of the necessity for a lay shaft, it was a natural preliminary to the eccentric. In addition to this, the engine is fitted with a separate cut-off valve operated by a cam upon the lay shaft. This valve is located at the end of the steam pipe, one valve thus serving for both ends of the cylinder, the cam having two lobes. The connecting rod from the valve crankpin is made with a gab end, permitting it to be disengaged and the valves to be worked by a hand lever when starting the engine. The valves are of the poppet type, the steam and exhaust valve for each end of the cylinder being eccentric with one another and the stem of one passing through the hollow stem of the other.

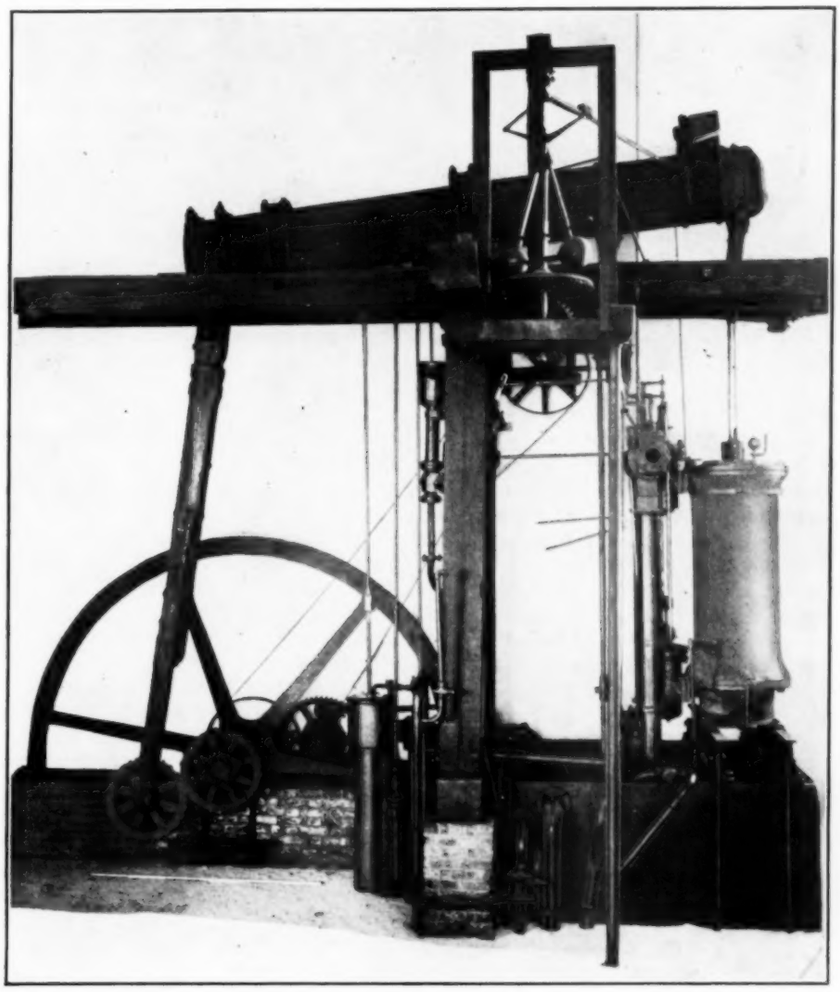


FIG. 2. ANOTHER SUN AND PLANET ENGINE SHOWING THE PROGRESS OF IMPROVEMENT—1797

In addition to these engines there are the main parts of a pumping engine erected in 1777, which, however, has not been photographed and which is so located as to make photographing too difficult for it to be undertaken. It antedates the parallel motion, having the horse-head-and-chain connection between the beam and the piston and pump rods.

Regarding the long terms of service of these engines, it should be said that they have been exceeded by other Watt engines, one of which, believed to be the first sold by Boulton & Watt, a pumping engine erected in 1776, continued at regular work for a period of 116 years, and was occasionally used for six years more. It is still preserved at Ocker Hill, Tipton, in working condition. It is much larger than the engines here shown, having a cylinder 33 inches diameter by 84-inch stroke, and was originally built to assist a water wheel in dry weather by pumping water from the tailrace back to the headrace. Long after the introduction of the rotative engine, this method of driving continued in use for textile mills, because of the more uniform speed when obtained from water wheels. The slide valve was invented by William Murdock, Watt's superintendent, and was employed in some cases, although Watt preferred the poppet.

Watt's First Condenser

As a classical relic of Watt's work, the palm must be given to Fig. 3, which shows the original experimental model of a separate condenser. It dates from 1765 and was undoubtedly made by Watt's own hand. It will be recalled that prior to Watt's time the steam was condensed within the cylinder by the aid of water injected therein, and this model was made in order to test his first and most fundamental invention—the separate condenser. It consists of a steam-jacketed cylinder, 1.4 inches diameter, fitted with a hemp-packed piston. From the piston a rod passes downward through a stuffing box and terminates in a hook, from which a weight of 18 pounds, indicating a vacuum of 12 pounds, was suspended. Connected to the upper end of the cylinder is a vertical pipe—

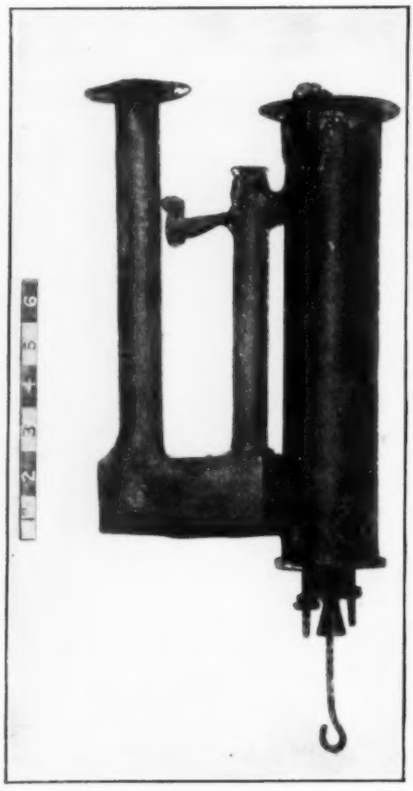


FIG. 3. ORIGINAL MODEL OF A SEPARATE CONDENSER

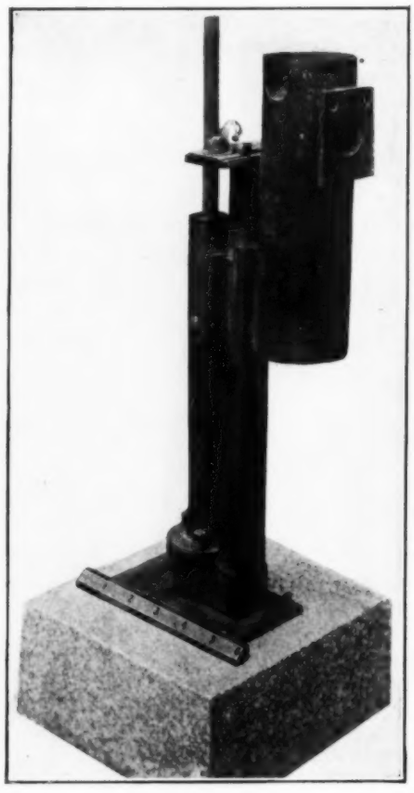


FIG. 4. ORIGINAL MODEL OF A SURFACE CONDENSER

the condenser—closed at the top and connecting below with a metal box from the further side of which passes upward a vertical tube which forms the air-pump barrel.

Most curiously, the model is now assembled in an unworkable manner, the first connection of the condenser being with the steam jacket, which in turn communicates with the lower end of the cylinder. There exists a proper connection with the upper end of the cylinder, which has been soldered over, and other features of the model show that the condenser connection must have been originally by this hole. It is surmised that after his experiments and before his patent was secured, Watt may have made this change in order to mislead anyone into whose hands the model might fall.

It should be noted, moreover, that as the model stands it is not a jet condenser, there being no opening for water into the condenser. The description states that the condenser and air pump were submerged in a tank of water, the condenser being thus of the surface type. At the same time, had there been an opening for water through the cover, it would have been easy for Watt to have removed this cover and replaced it with another in case he was bent on deceiving others. On the other hand, for the purpose of experiment, the cold surface may have given sufficient capacity without the jet.

THE FIRST SURFACE CONDENSER

Fig. 4 shows a model which is only second in interest to the one already shown. It bears a label reading "Original Model of a Surface Condenser," and was probably made shortly after the previous one, and if the previous one was originally a surface condenser this one represents a little more than an increase of surface. It contains an excellent condenser with 140 small tubes soldered into a metal tube plate at each end—the cooling water passing through the tubes and the steam to be condensed being admitted to the shell and outside the tubes.

The pipe next the condenser connects near its top with the condenser and at its bottom with the barrel of the air pump, which has a solid piston. The valves are fitted to the intermediate pipe —the delivery valve at the top of the pipe and the suction valve at its junction with the condenser—the actual pumping being thus done by the rising and falling water column—a superior construction, it will be remarked, because of its eliminating clearance.

Watt was obliged to abandon this con-

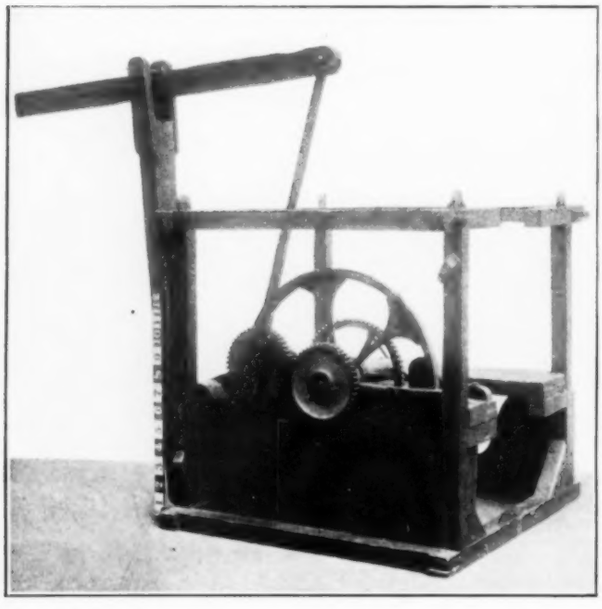


FIG. 5. WORKING MODEL OF A SUN AND PLANET GEAR

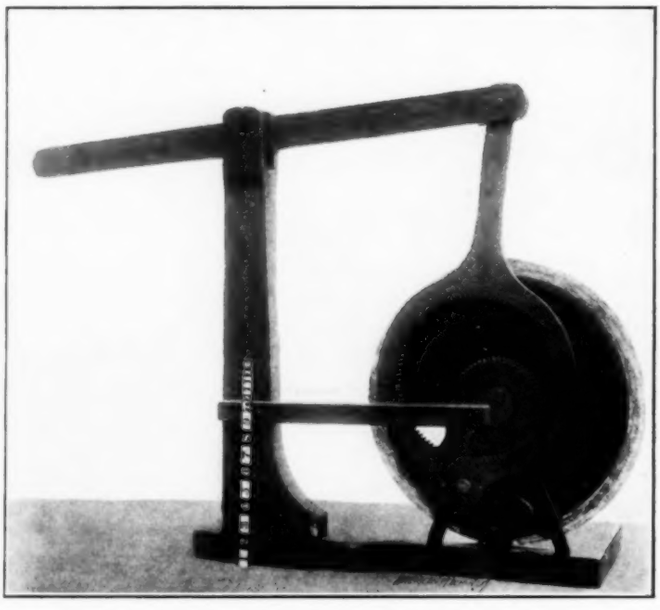


FIG. 6. WORKING MODEL OF AN INTERNAL GEAR CONNECTING ROD

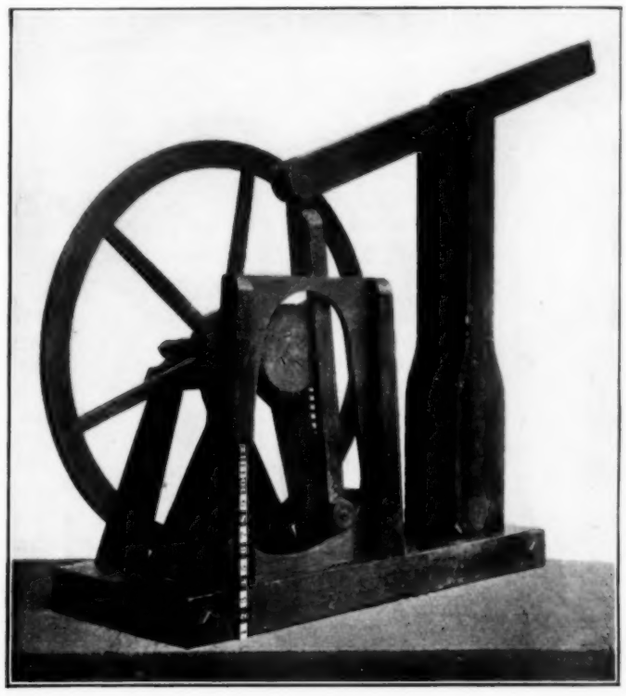


FIG. 7. MODEL OF A LADDER CONNECTING ROD

FIG. 8. WATT'S PLAN FOR DRIVING A FLOUR MILL

denser, because of the difficulty of keeping it tight—a difficulty which was not surmounted until long after his time.

STRANGE SUBSTITUTES FOR THE CRANK

Nothing seems so strange in connection with Watt's engine as the sun-and-planet gearing. The explanation of this construction lies in the fact that in the application of the crank he was forestalled by a patent taken out just in time to prevent his using it. Watt regarded the patent as a piece of piracy and refused to make terms with the patentee. In order to avoid this, he was forced to invent a substitute, and the sun and planet gear was the result. That the task was not an easy one is shown by the models of other devices, which he made before adopting this one. He was much given to model making, by the way, as were most of the old masters, and the museum contains a large number of examples other than those shown here, and of scarcely less interest. Among those included is Fig. 5, which is a working model of the sun-and-planet gear. A first cousin to this is found in Fig. 6, which is a model of an internal-gear connecting rod,* while perhaps the strang-

*The lack of roundness of the internal gear is due to the shrinkage of the material, which is wood.

FIG. 9. WATT'S PLAN FOR DRIVING A ROLLING MILL

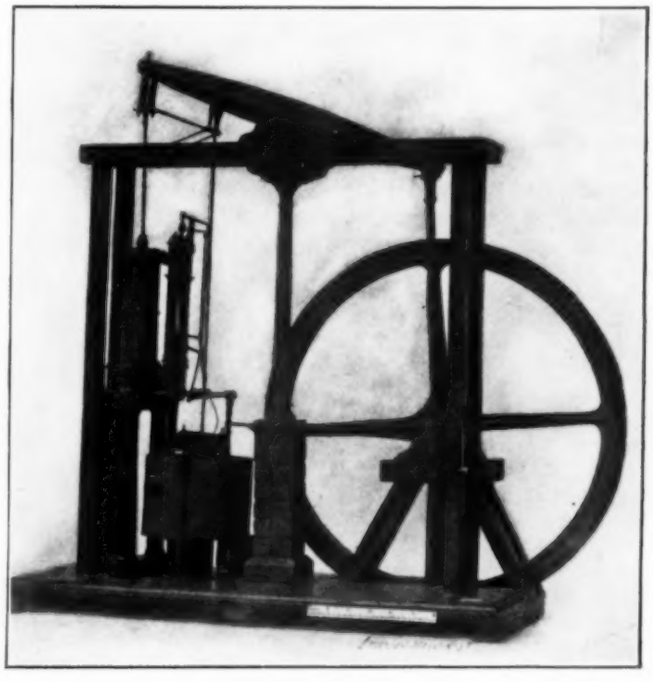


FIG. 10. A WATT MODEL ENGINE

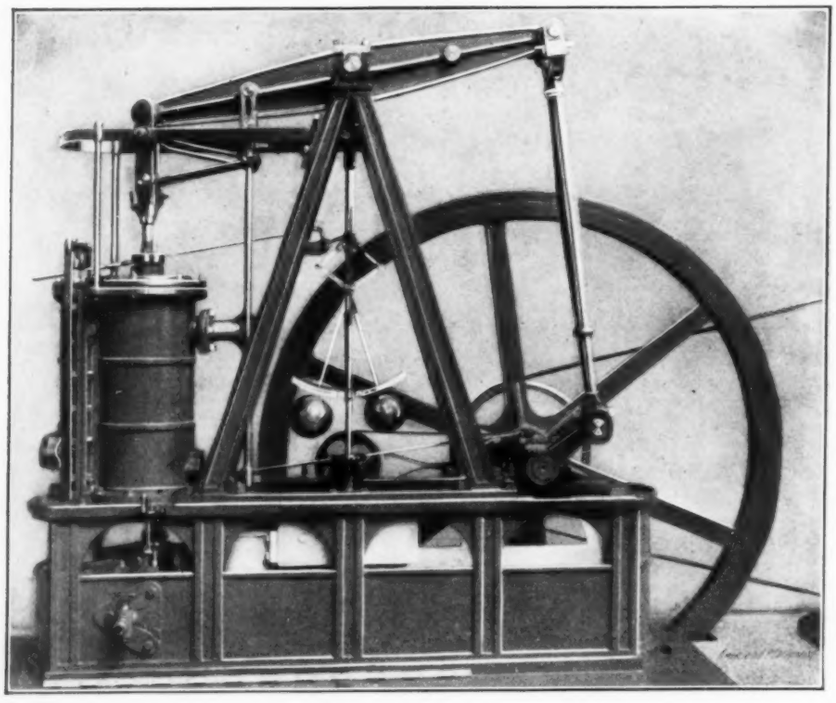


FIG. 11. ANOTHER MODEL ENGINE LEFT BY WATT

est of all is Fig. 7, which shows a "ladder-connecting rod," than which nothing could more strikingly illustrate the straits to which Watt was put. The main shaft ends in a gear, while the connecting rod carries at its end a long rack composed of rungs like a ladder and capable of acting on either side of the gear. At the lower end of the connecting rod is a roller which works in a large opening of special form in a fixed guide plate, which keeps the rack in mesh with the gear. At the conclusion of the downward stroke, when the last rung is in mesh, the lower end of the rod swings to the other side of the gear, being guided and maintained in mesh by the guide plate, the reverse movement taking place at the end of the upward stroke. Still other devices for the same purpose are shown in model form. In spite of its unpromising features, the sun and planet gear was continued in regular use until about 1800, when the embarrassing patent ran out.

DEMONSTRATION MODELS

It must be remembered that Watt was engaged in the introduction of the greatest innovation that engineering has ever seen. The driving of a revolving shaft by means of steam power originated with him and he had the problem before him of convincing owners of mills that his engine would form a successful substitute for water and horsepower. In order to demonstrate his ideas, he had recourse to many models, and among these is one shown in Fig. 8, to illustrate the application of his invention to the driving of flour mills, in which service, in fact, the engine found some of its earliest applications.

The model shows the method of driving a mill having six runs of stones. The connecting rod has two sun-and-planet motions, one on each side, each of which connects to a driving shaft carrying a flywheel. A bevel gear on each flywheel shaft meshes with a second bevel on a vertical shaft, which also carries a spur wheel meshing with three pinions, one on each of the mill spindles.

Fig. 9 shows a somewhat similar model of a rolling mill, and others showing forge hammers and other machinery driven by the engine are shown at the museum.

MODELS OF COMPLETE ENGINES

While many of Watt's models had a utilitarian purpose, he also made others for his personal gratification, and, whatever one may think of models in general, he cannot be other than thankful that Watt, and for that matter others, thus left records of their work. Among several of this kind that still exist is the one shown in Fig. 10, which was probably made about the year 1800. It is of far better workmanship than the demonstrating models, being, except for the frame, of metal. Like many other models throughout the museum, a compressed-air system is connected to its own cylinder, by which it is kept constantly in motion. The valves are of the poppet type and of the same construction as in the second large engine already described, and are driven by an eccentric working through a tappet gear. It will be seen that the sun-and-planet gear has disappeared. The steam cylinder of this model is 1⅝ inches diameter by 4½-inch stroke.

The gem of the collection from the modelmaker's standpoint is shown in Fig. 11, which was bequeathed by Watt to

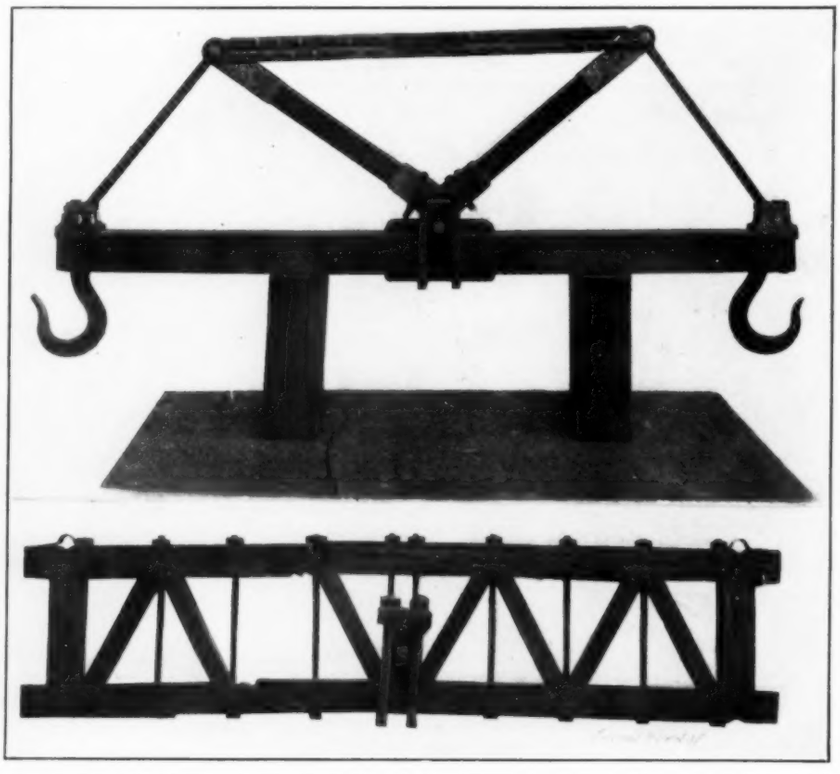


FIG. 12. TEST MODELS OF TRUSSED WORKING BEAMS

John Kennedy, of Manchester. It fairly represents the culmination of Watt's work and as a piece of model making it would be creditable to any model maker today. I am not informed of the size of the cylinder, but the bed plate measures about 3 feet in length overall. Unlike the last model shown and the larger engines, this one is fitted with a slide valve of the long "D" form, which is driven by an eccentric. The cylinder is steam jacketed and the engine is fitted with Watt's governor. The frame, including the bed plate, is of iron and of almost ideal form. The engine as here shown, remained substantially the standard construction for many years. The illustrations of "the steam engine," in many of our dictionaries and other books of reference might almost have been taken from this model. Like the last model shown, this one is kept in constant motion by means of compressed air turned into its own cylinder. By the belt shown it drives a modern sectional model, showing the action of valves and piston.

More Experimental Models

The condenser models will illustrate the well known fact that Watt was an experimental investigator, and the next illustration, Fig. 12, will show the same fact in a very different field of work. There is evidence that he had trouble in connection with the walking beams of his engines, and this illustration shows models of trussed beams which were made in order to determine the proper proportions of such beams. One of the models is plainly fitted for attaching test weights, while the other has been tested to destruction. It seems curious, by the way, that while Watt's earliest pumping engines were fitted with trussed beams, the beams of the mill engines which are shown were constructed of nothing but a single stick of timber.

Fig. 13. A Watt Indicator

An Old Steam Engine Indicator

The steam engineer of today will look with a sympathetic eye upon Fig. 13, which represents a steam-engine indicator as used during Watt's time. The actual date of the construction of this instrument is unknown, but it was the property of Watt's agents in Manchester.

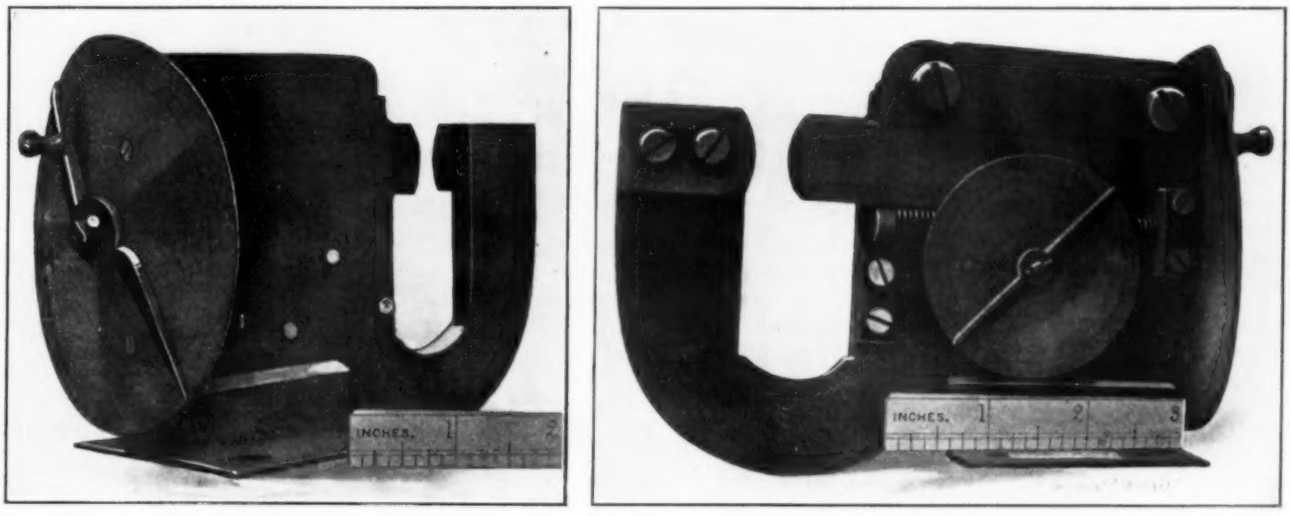


Fig. 14. Watt's Micrometer

It still carries a card which was taken in 1840, by Prof. E. Cowper. The instrument has a brass cylinder 1.13 inches diameter (1-square inch area).

The Father of Micrometers

If the last illustration is of prime interest to the steam engineer, the next and concluding one will be no less so to the working mechanic, for it illustrates a micrometer made by Watt. It has the regulation screw construction, although there is no nut. The screw has no endwise movement and the moving bar is fitted with teeth like inclined rack teeth, which engage the screw. The dial is stationary, the screw being turned by means of the bar which crosses the dial. Whole revolutions are counted by the index on the smaller dial, this index being turned by means of a small wormwheel, which meshes with the screw. The screw has 18 threads per inch, while the dial has 50 main divisions, which are subdivided into halves. The main divisions thus read to the 1/900 of an inch, while the subdivisions read to the 1/1800 part.

Purchasing Agent and the Treasurer

By Samuel L. Platt

A bargain that may seem advantageous to the purchasing agent may prove an embarrassment to the treasurer when the account becomes due. Co-operation is necessary between these departments, as between all other departments of the shop.

"Pull together," "use team work," "coöperate"—these are old adages that have been used for years to express the same thing that Lincoln meant when he said "United we stand, divided we fall." They are used in connection with all sorts of things, yet in one of their most useful fields—business life—they are often forgotten, overlooked, or thought to be inapplicable.

How often we see, in going around among machine shops, this lack of harmonious coöperation. The sales manager shows by his manner that he and the superintendent are not working together. The remark is often made that it's entirely the superintendent's fault that deliveries are not made as promised. When the general manager is called in to straighten matters out, his very attiture indicates that he is tired of such mix-ups, sometimes siding with one or the other or again raking them both over The outsider, seeing this condition of things and not caring a rap about whose fault it is, often loses his confidence in the concern, and becomes suspicious of the output for the reason of this lack of pulling together.

A Link That Is Frequently Weak

There is one place in every large company where team work can be used to great advantage; that is, between the financial and the purchasing departments. The purchasing agent, getting his requisitions from the shops, goes ahead and orders, making what seems to him the best terms possible. That the terms and deliveries from his point of view are advantageous, no one will deny.

When the payments are due and reach the treasurer, the advantage of those terms, etc., may prove a hard proposition for him. That particular month has many obligations other than the purchasing agent's shrewd bargains, even some particular day may drain, for the time being, the resources of the company. Credit is a ticklish thing, suspicion is easily aroused, taking extra time for payment cannot be indulged in often without causing comment.

The opportunity to get a concession in price, the temptation to buy in quantity, if delays and bother of deliveries have been met on previous orders, are often too much for the purchasing agent to resist, and he obligates the concern to heavy payments, thinking he has done well. Clever buying is an art and should always be recommended, but clever buying does not mean taking advantage of every seeming chance.

An extra 3 per cent. is worth looking after, but it may mean the borrowing from banks to meet the payment, which lessens the advantage by the interest paid. For example, suppose it made necessary a sixty-day loan; if at 6 per cent., 1 per cent. should come off the 3 per cent., making it only 2 per cent. The treasurer's relations with the banks, at the time, might be such that he would prefer not to increase the loans, yet he is forced to, simply because the two departments are not working in harmony.

Two Actual Conditions

In one large company these conditions came up frequently; the treasurer complained to the purchasing agent, the latter, thinking it was an interference with his domain, said he "couldn't bother to go upstairs and ask every time he wanted to buy a pencil; it wasn't his business, anyway, to run the finance. What was a treasurer for if he couldn't look out for such things?" The only arrangement they could agree on was that every order over a certain amount would be reported to the treasurer, thus giving him a little more chance to prepare.

Some little time after this arrangement was made, the purchasing agent left and a new man was engaged. Having been brought up, as the expression goes, "in another school," he saw the disadvantage of the old way. Getting the total purchases for the year, he figured what the months should average; then allowing for certain season purchases to cover possible interruptions to navigation, etc., he took these averages up with the treasurer, modifying them to suit the conditions the latter had to look out for. This gave him a working basis, and with careful study, arranging deliveries, terms of payment, etc., made it possible to keep within a very close margin of the monthly figures.

Any change in this procedure was taken up with the treasurer before going ahead. At times what would seem a bargain from the purchasing agent's view did not prove so in reality. Arranging, as they did, once or twice a year, made it just as easy for the purchasing agent and saved the hard feeling, worry and trouble experienced under the old order.

Value of Cooperation Cannot Be Overestimated

There are comparatively few concerns whose working capital is so great that there is no need of coöperation between these two departments, and even then the harmony produced by working together is worth while, even if not absolutely necessary.

"United we stand, divided we fall" is just as true in business concerns, if not more so, than with nations. Every man of experience knows of concerns that have failed because the partners or officers were pulling in opposite directions, were jealous of each other, or were trying to have everything their own way. With the financial and the purchasing departments there should be the closest cooperation instead of absolute independence of each other.

In the selection of material for use in the construction of automobiles, the laboratory method of arriving at conclusions is relied upon to produce dependable results. The *Automobile* states that it is shown in an article on testing steel how some of the results obtained carry with them a considerable measure of misfortune in that they cast doubt upon good materials, and fail to sufficiently lay bare the defects in the other kind. It would be good practice to rely upon the steel fabricator unchecked, in the face of a system of testing which falsifies.

Critical Speed Calculations*

By S. H. Weaver

In modern constructions where high speeds of machinery prevail the question of the critical speed is of great and increasing importance.

The critical speed is that at which the vibration produced by the unbalanced conditions becomes a maximum.

*Condensed from paper presented before the American Society of Mechanical Engineers.

Critical speed is the term applied to the speed of a rotating body at which occur the maximum vibrations of the revolving mass or supporting structure. The vibrations are smaller for speeds both above and below the critical value. Hence the importance to the designer of high rotative speed apparatus, of predetermining these maximum vibrating points. The high speeds and large capacities now being used in electrical machinery, such as turbo-generators, frequency changers, etc., bring this apparatus within the critical-speed range, and the electrical designer must study the vibrating properties of his high-speed machines, or leave this operating trouble to chance.

The phenomenon of critical speed was known to De Laval, who designed his turbines with a small or "flexible" shaft, so that the running speed was seven to ten times the critical value. So far as is known he did not understand the mathematical theory.

The first scientific explanation of critical speed is due to Rankine who, in *Machinery and Millwork*, gave the mathematical explanation for a shaft with its own weight only, when supported at each end, and also for fixed direction at one end as a cantilever. This was followed by Professor Greenhill with an explanation for an unloaded shaft with fixed direction at each end. Professor Reynolds then extended the mathematical treatment to shafts loaded with pulleys, and Professor Dunkerley proved the formulas by laboratory experiments and developed an approximate formula for shafts with more than one load. Reynolds and Dunkerley do not satisfactorily treat the case of two loads on the shaft and their method was criticized by Doctor Chree.

Föppl, in Germany, gave the case for a single concentrated load on the shaft. Stodola, in 1903, first gave the formula for any two concentrated loads on a shaft. Professor Morley has lately given approximate formulas for combined distributed and concentrated loads.

These constitute practically all of the literature on the subject. They are mainly mathematical demonstrations and do not leave the subject in convenient form for the use of the designing engineer. This paper will give a mathematical treatment for both the distributed and the concentrated loads, by considering the motion of the shaft as vibratory along two axes, study the vibrations for all speeds, reduce the formulas to practical form, and present them in tables for convenient use.

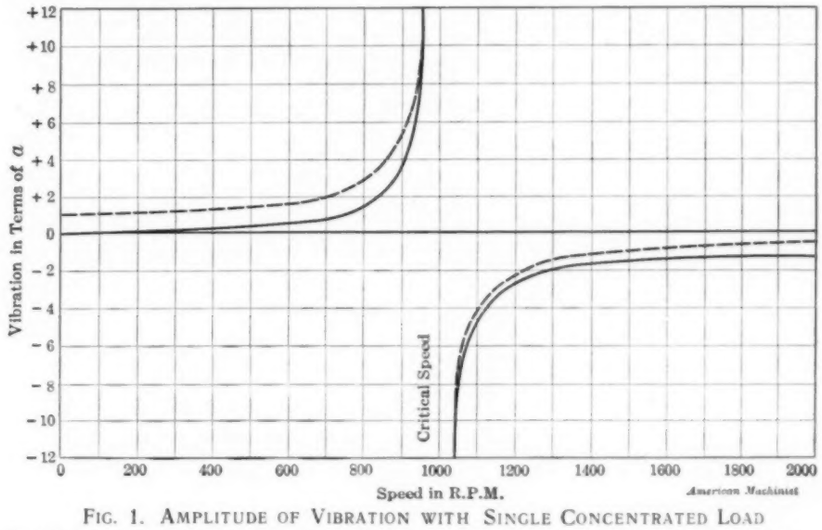


FIG. 1. AMPLITUDE OF VIBRATION WITH SINGLE CONCENTRATED LOAD
Dotted line for motion of center of gravity. Solid line for motion of shaft center.

NATURE OF CRITICAL SPEED

All critical-speed calculations assume an unbalanced load. It is practically impossible to balance a rotating mass so that its center of gravity exactly coincides with the mechanical axis of rotation. As the mass starts to rotate, the center of gravity will rotate in a very small radius around the shaft center. The rotation of the center of gravity at this small radius produces a centrifugal force which acts radially outward from the shaft center through the center of gravity, and rotates around the shaft with the center of gravity. Consider the case of a single concentrated load on a vertical shaft. Let a be the unknown distance from the center of gravity of the mass to the center of the shaft. The centrifugal force of this mass m, rotating at the radius a, will tend to deflect the shaft in the direction of a, so that the shaft will rotate in a bowed condition. The bowed shape will in itself increase the circle in which the center of gravity rotates; this increases the centrifugal force, and in turn the shaft deflection. This action continues until finally a state of equilibrium is reached where the force of the shaft deflection is equal and opposite to the centrifugal force of the mass. This condition of equilibrium for any speed can be mathematically calculated from the formulas of centrifugal force and shaft deflection. If then a curve is plotted, showing the relation of shaft bending to speed of rotation, it will be found that as the angular speed increases from zero the deflection increases, until the latter becomes theoretically infinite.

This is the condition of maximum vibration produced by the shaft, and the critical number of revolutions can be definitely calculated. Such a curve is shown in Fig. 1.

Referring to the curve beyond the critical-speed value, the vibration amplitude becomes negative, and as the speed is increased, approaches the limit of zero; in other words, above the critical speed the center of gravity revolves inside the bow of the shaft, or in a smaller circle than the shaft center; and the tendency of the rotating mass is to rotate about its own center of gravity, and not about the mechanical center. It approaches its center of gravity as a limit for infinite speed. It is also determined from the calculations that for a single concentrated load the critical-speed phenomena occur when the revolutions synchronize with the natural period of vibration of the shaft. No satisfactory explanation has been given of the detail action at the critical speed, or of the manner in which the center of gravity passes from the outside to the inside of the bow of the shaft. Theoretically the deflection or bow of the shaft becomes infinite at the critical speed. Practically it does not, because of the resistance of the air and probably the need of the factor of time to accumulate energy.

In machines where the normal running speed is higher than the critical speed, the shaft is made just strong enough to withstand the deflection in

passing through the critical speed, and as weak or flexible as possible for the smooth running above the critical speed. The weaker the shaft, the lower the critical speed, the nearer approach to rotation about the center of gravity, and the less bow or deflection in the shaft.

This solution is satisfactory so far as the critical value and deflection of the rotating mass is concerned, and it affords a simple explanation of the actions of a rotating body. But in the design of a machine the vibrations of the frame or supporting structure are of equal or greater importance. The shaft rotating in its bowed condition has a reaction on the bearing points, the reaction rotating with the shaft. This force is the impressed vibration that causes the frame to vibrate. If we determine the shaft deflection during rotation, or the location of the shaft axis at any instant, we can find the amount of the force of the shaft, or the impressed vibration on the frame.

These considerations and calculations may be extended to any two concentrated loads with either two or three bearing supports. In these cases the equation gives two values of critical speed for two concentrated loads regardless of the method of support, for either two or three bearings. It can be further shown that with a uniformly loaded shaft there is an infinite number of critical speeds and that the shaft becomes bowed differently for each one. The condition up to the first critical speed is shown in Fig. 2*a*; between the first and second critical speeds as in Fig. 2*b*; between the second and third critical speeds as in Fig. 2*c*, and so on.

General Observations

All formulas developed for critical speed, for both concentrated and distributed loads, apply to vertical shafts as well as horizontal. Although some formulas use the static deflection $\triangle$, this is an equivalent deflection and can be used for vertical shafts by considering them horizontal.

As previously pointed out, theoretically the vibrations become infinite at the critical speed; actually they do not, but the vibrations are at a maximum point. As shown by the curves of Fig. 1, the vibrations will begin at a certain speed, increase as the speed increases, and with still increasing speed will after a while die away. The vibrations may be felt over a considerable range, and the exact point of maximum value is difficult to detect. It is, therefore, advisable to keep the running speed at least 20 per cent. away from the critical value; and if the normal speed is between two critical values, careful calculations should be made for the point of minimum vibration.

Under ordinary circumstances the speed should be considerably below the critical value, as then the balance need not be particularly good. When the speed is considerably above the critical value, the vibration is almost proportional to the unbalance, or distance of the center of gravity from the center of the shaft, and the flexibility of the shaft; and the balance should be good, to prevent injury to the shaft and excessive vibration when passing through the critical speed.

A machine may be run very close to or at the critical speed, but the alinement and play of bearings, all mechanical details and the balance will require extra care, so that a troublesome and more expensive machine results before it is in good operating condition. The machine will run smoothly for a considerable time, until some mechanical fit or play causes a slight unbalance and immediately sets up excessive vibrations.

The equations for vibration further show that during the critical-speed period the vibrations increase theoretically with the time, so that in machines running above the critical speed there is less vibration at the critical-speed point when it is rapidly passed over. The equations also show a transfer of energy; the kinetic energy from the unbalance being transformed into the potential energy of the shaft deflection, so that a machine with nearly perfect balance may run smoothly for considerable time at the critical speed before vibrations appear. I have not seen or had sufficient proof of the action of these particular equations, but they may explain some of the peculiar phenomena observed in the vibration of certain machines.

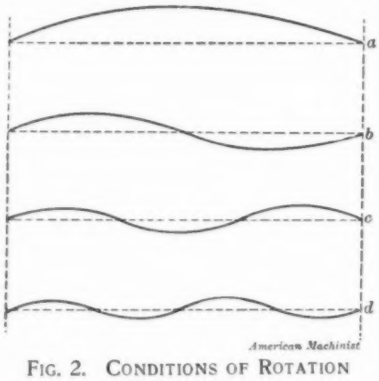


Fig. 2. Conditions of Rotation

With excessive vibration in passing through the critical speed there is a considerable tendency to spring the shaft by giving it a permanent set. This is most dangerous when the machine is first started, before it has a running balance. Partly for this reason many designers use the more expensive nickel-steel forged shaft instead of carbon steel. With due consideration of the smaller coefficient of expansion of nickel-steel, in distorting large shafts when all parts are not at the same temperature, and of the fatigue or reversal of fiber stress in horizontal shafts, the machine and shaft can be so proportioned for smooth running that the finer grade of shaft steel is not always necessary.

The formulas developed in this paper have been transformed to suit a number of special conditions, and placed in tabulated form for convenient use. The data required for the solution of critical-speed problems are the same as those for shaft deflection at loads. As the shaft is usually of variable diameter, and its stiffness is increased by a long hub, an ideal shaft of uniform diameter and equal stiffness, or for the same deflection, must be assumed. The loads are usually concentrated with an ideal point of application. The weights and distances between bearings and loads are the same in the ideal as in the actual case. Experience has shown that when the largest shaft diameter and uniform load cover about one-third of the span, approximately the same deflection is given for the load concentrated with a uniform shaft of the largest diameter. The weight of the shaft can be divided among the concentrated loads. As formulas have not been developed for more than two loads, when more than two loads are given they must be transformed into two resultant loads that would give the same deflection. For this case, two critical speeds will be found, one of which is usually far from the working speed.

New Idea for Railroad Tracks

The latest suggestion regarding the improvements of railway tracks is the scheme of Levert Clark, of Detroit, Mich. This consists of placing an extra rail on the outside of each rail as now used, and of extending the axles so that a plain tired wheel may be mounted in the proper position to run on this extra outer rail. This would give a double-rail bearing for the same load, and is not only proposed on account of being easier on tracks, but also for safety. Should any axle jump the track in either direction, the wheels are to be caught between the two rails and prevent serious accident. It is also claimed to give equal braking capacity with less wear on wheels and shoes.

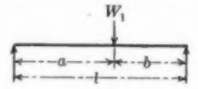
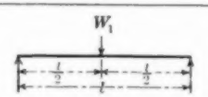
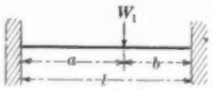
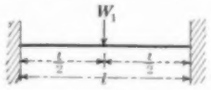
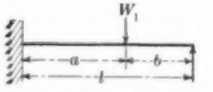
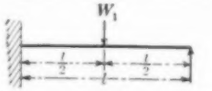
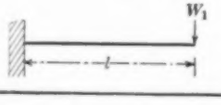
We fear that those who are familiar with railway practice will see many difficulties in the way of its adoption, besides those of first cost and maintenance, as it would be extremely difficult to keep the rails in such perfect alinement that both wheels would bear with even approximately equal pressure, and any great difference would throw excessive strain on the axle. It would also add considerably to the difficulty of adjusting brake shoes, but all the difficulties which confront us in regard to cars would be multiplied when it came to the locomotive itself.

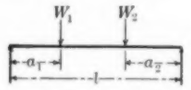
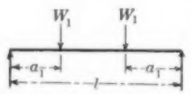
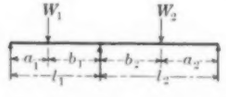
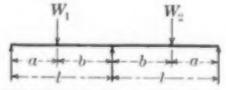
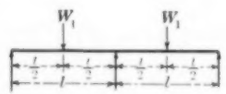
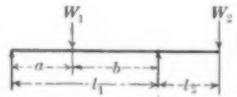
Weights in pounds, dimensions in inches, vertical shafts considered horizontal.

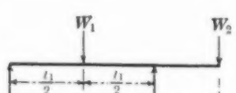
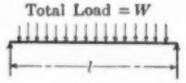
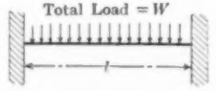
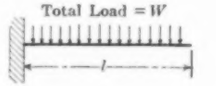
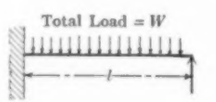
N, N_1, N_2 = critical speeds in revolutions per minute.

Δ_1, Δ_2 = static deflections at W_1 and W_2 (shaft horizontal).

d = diameter of shaft (inches). $E = 29{,}000{,}000$.

Single Concentrated Load General Formulae		
	$N_1 = \frac{187.7}{\sqrt{\Delta_1}}$	1
	$N_1 = 387{,}000\ \frac{d^2}{ab}\sqrt{\frac{l}{W_1}}$	2
	$N_1 = 187.7\sqrt{\frac{1}{\Delta_1}}$	1
	$\Delta_1 = \frac{W_1 a^2 b^2}{3EIl}$	3
	$N_1 = 1{,}550{,}500\, d^2\sqrt{\frac{1}{W_1 l^3}}$	4
	$N_1 = 187.7\sqrt{\frac{1}{\Delta_1}}$	1
	$\Delta_1 = \frac{W_1 l^3}{48EI}$	5
	$N_1 = 387{,}000\, d^2\sqrt{\frac{l^3}{W_1 a^3 b^2}}$	6
	$N_1 = 187.7\sqrt{\frac{1}{\Delta_1}}$	1
	$\Delta_1 = \frac{W_1 a^3 b^3}{3EIl^3}$	7
	$N_1 = 3{,}100{,}850\, d^2\sqrt{\frac{1}{W_1 l^3}}$	8
	$N_1 = 187.7\sqrt{\frac{1}{\Delta_1}}$	1
	$\Delta_1 = \frac{W_1 l^3}{192EI}$	9
	$N_1 = 775{,}200\, \frac{d^2 l}{a^2 b}\sqrt{\frac{l}{W_1 a (3l+b)}}$	10
	$N_1 = 187.7\sqrt{\frac{1}{\Delta_1}}$	1
	$\Delta_1 = \frac{W_1 a^3 b^3}{12EIl^3}(3l+b)$	11
	$N_1 = 2{,}337{,}000\ \frac{d^2}{l}\sqrt{\frac{1}{W_1 l}}$	12
	$N_1 = 187.7\sqrt{\frac{1}{\Delta_1}}$	1
	$\Delta_1 = \frac{7}{768}\ \frac{W_1 l^3}{EI}$	13
	$N_1 = 387{,}000\, d^2\sqrt{\frac{1}{W_1 l^3}}$	14
	$N_1 = 187.7\sqrt{\frac{1}{\Delta_1}}$	1
	$\Delta_1 = \frac{W_1 l^3}{3EI}$	15

Two Concentrated Loads General Formulae		
	$\frac{N_1}{N_2}$ and $\frac{d}{l} = 132.3\sqrt{\left(\frac{K_1}{W_1}+\frac{K_2}{W_2}\right)\pm\sqrt{\left(\frac{K_1}{W_1}-\frac{K_2}{W_2}\right)^2+\frac{4K_3^2}{W_1 W_2}}}$	16
	$C = \frac{6EI}{(l-a_1-a_2)^2[l(3l-2a_1-2a_2)-(a_1-a_2)^2]}$	17
	$K_1 = C\frac{a_2}{a_1}l(l-a_1)^2$	18
	$K_2 = C\frac{a_1}{a_2}l(l-a_2)^2$	19
	$K_3 = C\frac{l(l^2-a_1^2-a_2^2)-a_1a_2(a_1-a_2)}{a_1a_2}$	20
	N_1 and N_2 = Substitute in Equation 16	
	$N_1 = 548{,}400\ \frac{d^2}{a_1(l-2a_1)}\sqrt{\frac{l}{W_1}}$	22
	$N_2 = 548{,}400\ \frac{d^2}{a_1}\sqrt{\frac{1}{W_1(3l-4a_1)}}$	23
	$N_2 = 187.7\sqrt{\frac{1}{\Delta_1}}$	24
	$\Delta_1 = \frac{W_1 a_1^2}{6EI}(3l-4a_1)$	25
	$C = \frac{3EI}{4l_1l_2'(l_1+l_2)-l_1(l_2+a_2)^2-l_2'(l_1+a_1)^2}$	26
	$K_1 = \left(\frac{l_1}{a_1b_1}\right)^2 C[4l_2(l_1+l_2)-(l_2+a_2)^2]$	27
	$K_2 = \left(\frac{l_2}{a_2b_2}\right)^2 C[4l_1(l_1+l_2)-(l_1+a_1)^2]$	28
	$K_3 = \frac{l_1l_2}{a_1b_1a_2b_2}C(l_1+a_1)(l_2+a_1)$	29
	N_1 and N_2 = Substitute in Equation 16	
	$C = \frac{3EIl}{2a^2b^2[4l^2-(l+a)^2]}$	30
	$K_1 = K_2 = C[8l^2-(l+a)^2]$	31
	$K_3 = C(l+a)^2$	32
	N_1 and N_2 = Substitute in Equation 16	
	$N_1 = 1{,}547{,}000\ d^2\sqrt{\frac{1}{W_1 l}}$	33
	$N_1 = 124.3\sqrt{\frac{1}{\Delta_1}}$	34
	$N_2 = 2{,}337{,}000\ d^2\sqrt{\frac{1}{W_1 l^3}}$	35
	$N_2 = 187.7\sqrt{\frac{1}{\Delta_1}}$	36
	$\Delta_1 = \frac{7}{768}\ \frac{W_1 l^3}{EI}$	37
	$C = \frac{12EI}{a^2l_1^2[4b^2l_1(l_1+l_2)+l(l_1^2-a^2)^2]}$	38
	$K_1 = Cl_1^2l_2^2(l_1+l_2)$	39
	$K_2 = Ca^2b^2l_1$	40
	$K_3 = \frac{C}{2}\,al_1l_2(l_1^2-a^2)$	41
	N_1 and N_2 = Substitute in Equation 16	
	$\Delta_1 = \frac{W_1a^2b^2}{3EIl_1} - W_2\frac{al_2}{6EIl_1}(l_1^2-a^2)$	42
	$\Delta_2 = \frac{W_2l_2^2}{3EI}(l_1+l_2) - W_1\frac{a\,l_2}{6EIl_1}(l_1^2-a^2)$	43

	$C = \frac{3EI}{l_1^2l_2^2(l_1+l_2)-\frac{9}{16}l_1^3l_2^2}$	44
	$K_1 = 16Cl_2^2(l_1+l_2)$	45
	$K_2 = Cl_1^3$	46
	$K_3 = 3Cl_1^2l_2$	47
	N_1 and N_2 = Substitute in Equation 16	
	$\Delta_1 = \frac{W_1l_1^3}{48EI} - \frac{W_2l_2l_1^2}{16EI}$	48
	$\Delta_2 = \frac{W_2l_2(l_1+l_2)}{3EI} - \frac{W_1l_2l_1^2}{16EI}$	49
Distributed Loads. – Δ = Maximum Static Deflection.		
	$N_1 = 2{,}232{,}510\, d^2\sqrt{\frac{1}{Wl^3}}$	50
	$N_1 = 211.4\sqrt{\frac{1}{\Delta}}$	51
	$N_1 = 4{,}760{,}000\ \frac{d}{l^2}$ (Shaft alone)	52
	$N = [1, 4, 9, 16, \text{Etc.}]N_1$	53
	$\Delta = \frac{5}{384}\ \frac{Wl^3}{EI}$	54
	$N_1 = 4{,}979{,}250\, d^2\sqrt{\frac{1}{Wl^3}}$	55
	$N_1 = 245\sqrt{\frac{1}{\Delta}}$	56
	$N_1 = 10{,}616{,}740\ \frac{d}{l^2}$ (Shaft alone)	57
	$N = [1, 2.78, 5.45, 9, \text{Etc.}]N_1$	58
	$\Delta = \frac{Wl^3}{384EI}$	59
	$N_1 = 795{,}196\, d^2\sqrt{\frac{1}{Wl^3}}$	60
	$N_1 = 167.6\sqrt{\frac{1}{\Delta}}$	61
	$N_1 = 1{,}695{,}514\ \frac{d}{l^2}$ (Shaft alone)	62
	$N = [1, 6.34, 17.6, 43.6, \text{Etc.}]N_1$	63
	$\Delta = \frac{Wl^3}{8EI}$	64
	$N_1 = 3{,}482{,}715\, d^2\sqrt{\frac{1}{Wl^3}}$	65
	$N_1 = 209.7\sqrt{\frac{1}{\Delta}}$	66
	$N_1 = 7{,}021{,}600\ \frac{d}{l^2}$ (Shaft alone)	67
	$N = [1, 3.24, 6.8, 11.6, \text{Etc.}]N_1$	68
	$\Delta = \frac{Wl^3}{185EI}$	69

American Machinist

FORMULAS FOR CRITICAL SPEEDS OF SHAFTS WITH ONE AND TWO CONCENTRATED LOADS, UNIFORM LOAD, TWO AND THREE SUPPORTS

A Novel Micrometer Hight Gage

By C. L. Goodrich*

The illustrations show a novel gage which has a wide field of application. It was designed mainly to take the place of size blocks or thickness gages for use on the planer or milling machine on tool work, but obviously it may be used in many other cases.

The tool is so constructed that a 0.010 inch minus setting of the planer tool may be made (as in Fig. 1) and in connection with two-ring gages any plus reading up to seven inches.

*Department foreman, Pratt & Whitney Company.

The anvil, as may be seen, is cut away so as to permit the passage of a tool, and the end of the micrometer barrel is below the anvil rim. The rim is exactly 0.250 inch thick and the graduations on the barrel have two series of numbers indicating dimensions, one set being used in connection with one side of the anvil, and the other set when the opposite side of the anvil is used as a registering point. This tool will appeal to the mechanic who uses size blocks to any extent and who appreciates their limitations.

As shown in Fig. 1, the micrometer is adjusted and the tool set to take 0.005 inch off the top of the planer table. Figs. 2, 3 and 4 show the gage in other working positions.

This tool has been invented, developed and patented by J. E. Leach and W. C. Woodman, two well known mechanics, of Norwich, Conn., but is not being manufactured for sale.

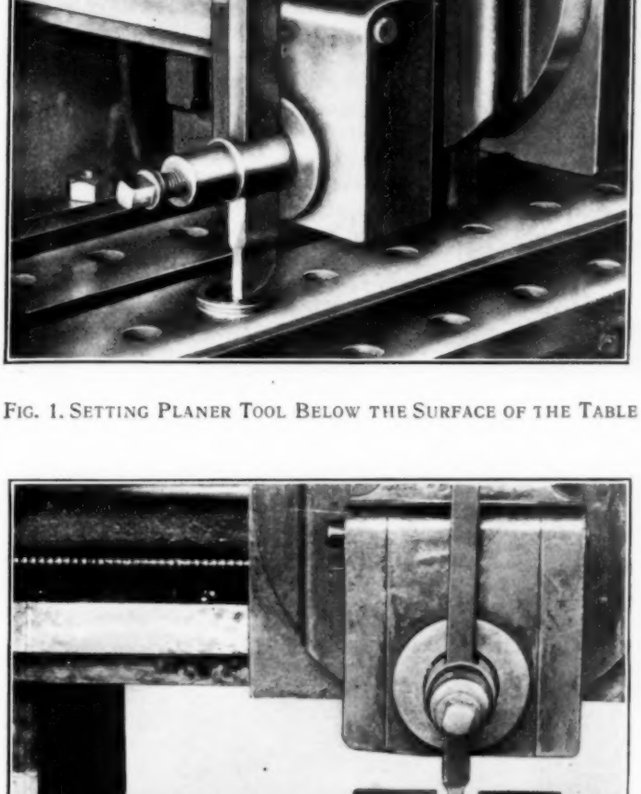


FIG. 1. SETTING PLANER TOOL BELOW THE SURFACE OF THE TABLE

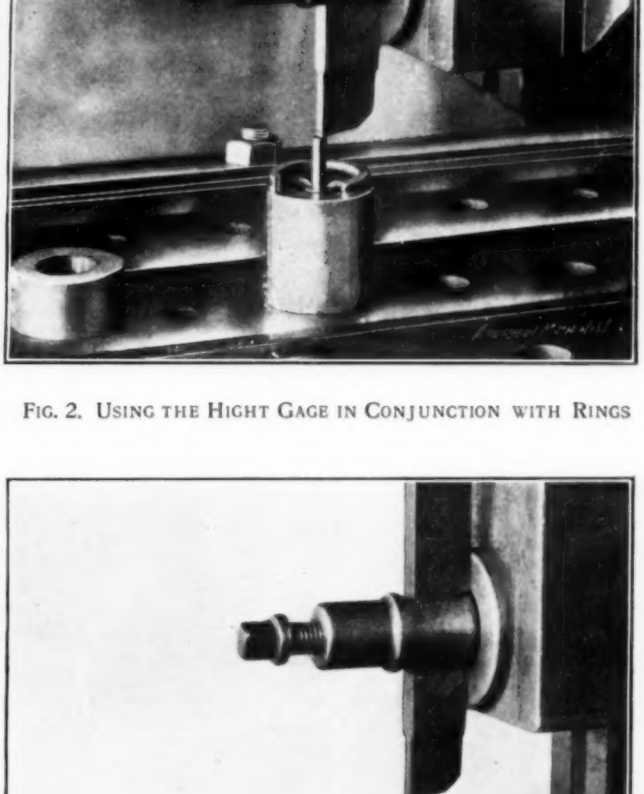


FIG. 2. USING THE HIGHT GAGE IN CONJUNCTION WITH RINGS

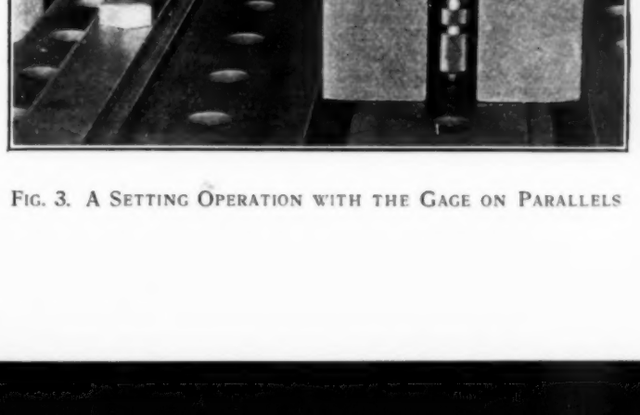


FIG. 3. A SETTING OPERATION WITH THE GAGE ON PARALLELS

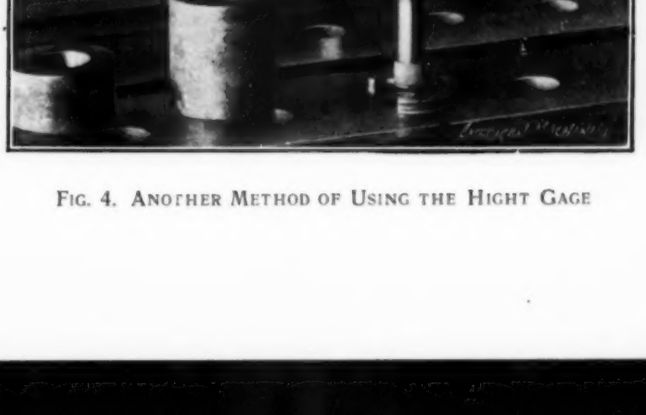


FIG. 4. ANOTHER METHOD OF USING THE HIGHT GAGE

Building the Wright Aeroplane

By Fred H. Colvin

Where strength is of more importance than lightness and efficiency of motor and propeller of great importance. Aluminum is only used for water jackets and held by shrinking on iron bands.

Flying suggests lightness, and we naturally think of aëroplanes as being the lightest structures possible. And yet the Wrights do not make this the first consideration by any means. Strength of structure, power and reliability in the motor are the chief requisites and lightness is not necessarily a recommendation.

To this end the framework is of spruce, not a joint is made of aluminum, the magneto used weighs 37 pounds, although some weigh but 15 pounds, the driving chains are very heavy, and every possible precaution is taken to make machines absolutely safe and reliable. Even the motor weighs over five pounds to the horsepower, though many are built much lighter. Not a turnbuckle is used in the guywires, each wire being put in place under the proper tension and securely fastened at each end. The stiffness of the whole structure is remarkable.

FIG. 1. INTERIOR OF WRIGHT MACHINE SHOP

An interesting feature is that the motor is only rated at 35 horsepower, and while the weight of the machine is about 850 pounds, much heavier than some others, the speed attained with a smaller motor is nearly as great, which looks as though the efficiency of everything from the supporting power of the wings to the propellers must be very high.

The Wrights used to be in the bicycle business and the motors are still being made in the old shop on West Third street, in Dayton, Ohio. The framework is made in another shop where the machines are assembled. Later in the year a good sized plant is to be erected to build the complete machines in a commercial way.

They have recently built ten machines, especially for demonstrating purpose, one of the latest being shown in Fig. 3. They have taught and are still teaching aviators for demonstration purposes. One of these is Walter Brookins, who has recently broken the record for high flying by rising over 4500 feet at the Indianapolis track. Roy Knabenshue, of dirigible fame, is prominent in this department, while the business management is in charge of Frank H. Russell.

The engines are of novel design, built with four separate cylinders, finished inside and out and having the valves in the head. In the small shop they are turned on the outside, held in a special chuck for boring and turning the projection which fits the base, and ground with a tool-post grinder.

The pistons have three snap rings of substantial cross section, and only the exhaust valve is mechanically operated.

The jackets are of aluminum, finished inside and out and forced over the cylinder flanges, about 0.01 inch being allowed for this. In addition to this, a steel ring is shrunk on at each end, with a shrinkage allowance of about 0.07 inch, holding the jackets firmly against the cylinder flanges. These jackets and the engine base are the only parts of the machine made of aluminum.

This construction is clearly shown in Fig. 4.

The new factory will, of course, have a modern tool equipment, but a very human interest attaches to the little old

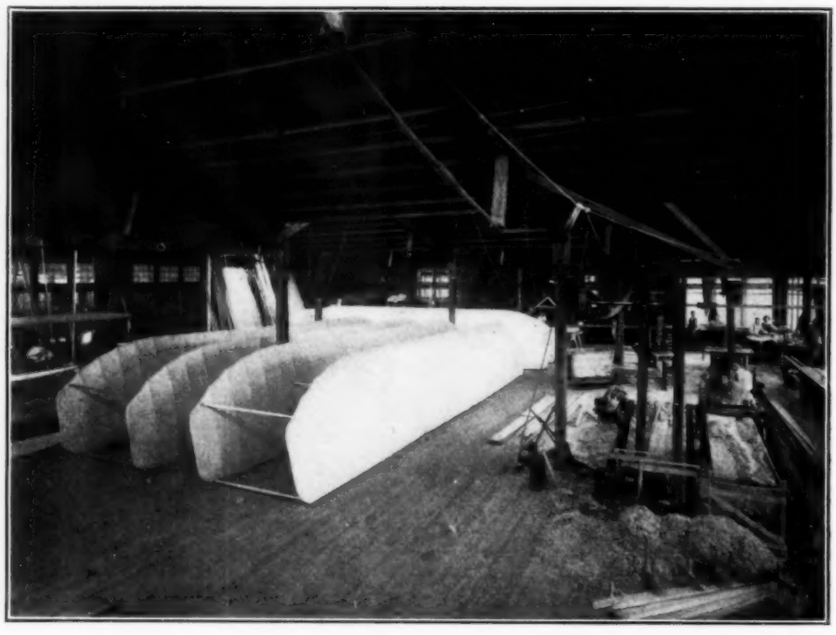


FIG. 2. MAKING THE PLANES

shop where the successful flying machine was developed. And we can but admire the perseverance as well as the business acumen, which brought success against great odds and which kept on in a small way until this success was assured, in preference to excessive expansion too early in the game.

The modern part of the equipment, for there are three Hendey lathes and an American back-geared shaper, will form the nucleus of the new plant. The lathes are shown in Fig. 1, the operator in the foreground machining chain sprockets, while in Fig. 2 are shown the main planes, to the right of which can be seen the wood-working machinery.

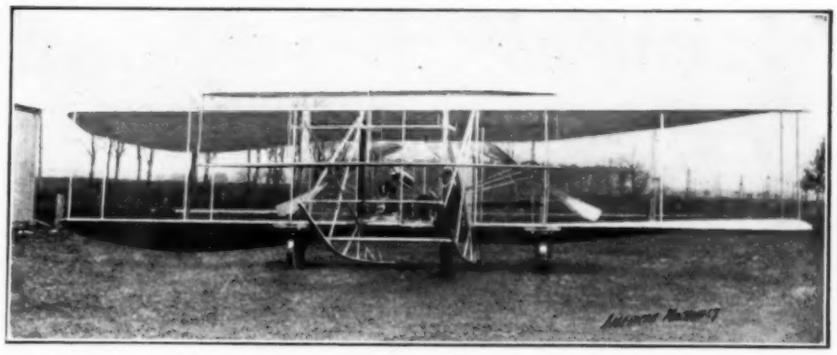


FIG. 3. LATEST TYPE OF WRIGHT AEROPLANE SHOWING HOW THE WINGS ARE WARPED

Comments on Gear Efficiency

By C. H. Logue

No thorough investigation has yet been made of the efficiency of gears, and very few data of any sort have been published, therefore little can be said. One thing is tolerably well known; the efficiency of a gear drive varies with its ratio—that is, a reduction of 2 to 1 will be more efficient than one of 10 to 1. Other features governing the efficiency are the accuracy with which the teeth are formed and spaced, the arc and obliquity of action, and the condition of the engaging surfaces. It is generally conceded that the length of face does not affect the efficiency.

This loss comes mainly through the sliding action of the teeth when entering and leaving contact; it would seem, therefore, that the arc of action should be as short as possible, carrying the load of that portion of the tooth where it can be best borne, also as there is less friction in the arc of recess than in the arc of approach it will increase the efficiency to lengthen the addendum of the driving gear. The contact, however, should be for an equal distance above and below the pitch line to avoid extreme sliding friction. If the entire action were rolling contact, there would be little loss.

Within a reasonable range of speed and load the efficiency of a gear drive will remain fairly constant. The formula following is based upon this and upon the efficiency varying with the ratio. It is simply the writer's idea of gear efficiency, based on this assumption and past experience. No other claim is made for it.

The values for constant P are for full load, as it is easily seen that the loss will be great in case the gears are disproportionately heavy, as energy must be used to actuate the gear before any real work is done. It is assumed that the speed does not affect the efficiency.

Gears connecting parallel shafts are the most efficient. Next in point of efficiency are gears connecting shafts at an angle in the same plane, varying again with the shaft angle. And last of all, gears connecting shafts at an angle not in the same plane, such as spiral, worm and skew-bevel gears.

$$e = \frac{P}{P + R}$$

In which

P = constant for various types of gears.

R = ratio of gear drive.

e = efficiency at full load.

	Value of P.
Herringbone gear, 45-degree angle..	320
Herringbone gear, 30-degree angle..	250
Internal gear, commercial cut.....	90
Stepped spur gear, commercial cut	100
Spur gear, generated or exact cutters	110
Spur gear, commercial cut.....	80
Bevel gear, generated teeth.....	90
Bevel gear, planed teeth.....	75

For lubricated gears, add 3 per cent.

Example:

In a pair of commercially cut spur gears of a ratio of 4 to 1, the efficiency would be

$$e = \frac{P}{P + R} = \frac{80}{80 + 4} = 95.2 \text{ per cent.}$$

The latest news in shipbuilding lines is the reported building of a new 60,000-ton steamship for the Cunard line. It is said that this will be in commission in three years, the Mersey Harbor Board agreeing to build a dock large enough to hold it. The length is given as 1000 feet, 210 feet longer than the "Mauretania," and 40 feet longer than the new White Star boats, not yet in service.

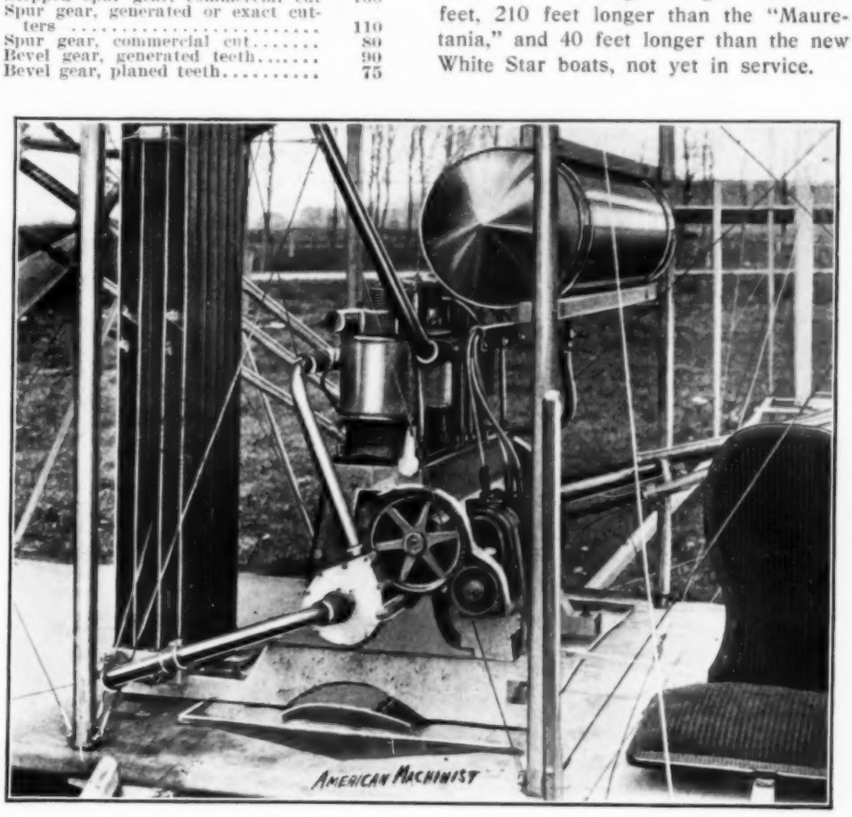


FIG. 4. THE WRIGHT ENGINE WITH JACKETS OF ALUMINUM

Machining an Engine Frame

Editorial Correspondence

A story, almost without words, of machining an engine frame complete at one setting.

One of the problems in manufacturing is to know when it will pay to equip with machines for doing one operation and move the work from one machine to another, and when to use a machine which will do all the required operations at one setting. This is determined by the number of pieces to be machined, as well as the weight of the pieces, but it is quite certain that in the average shop the latter method will be found more economical, except on comparatively small work.

The accompanying illustrations show a case of this kind, in which an engine frame is machined completely on a universal horizontal drilling, boring and milling machine of the floor type.

The engine frame is mounted on the universal table shown, and in Fig. 1 is having the guide bored by a cutter head on an extension bar, which is driven by the spindle and has its outer end supported in the bearing shown. At the same setting the flange to which the cylinder is bolted is trued up with a facing arm, and the holes in this flange are also drilled by removing the bars from the spindle and using a drill in its place.

In Fig. 2 the table has been swung 90 degrees, so that the sides and edges of the frame opening can be milled, the necessary milling cutters being easily carried by the bar, as can be plainly seen.

In Fig. 3 the universal table carrying the engine frame has been tilted to the desired angle, so that the faces of the crankshaft bearing can be milled for the taps. Replacing the milling cutter with a drill, these bearings are drilled for the bolts, with the work held in the same position, so that the bolt holes are sure to be at right angle to the milled faces.

Fig. 4 shows the table top tilted to a right-angle position with the base, so that the end of the frame can be milled as shown, as well as a little other milling and drilling, which is required to complete work on this frame.

This is almost a story without words and is simply given to illustrate a method of handling work without re-setting. This particular machine is built by the Detrick & Harvey Machine Company, Baltimore, Md.

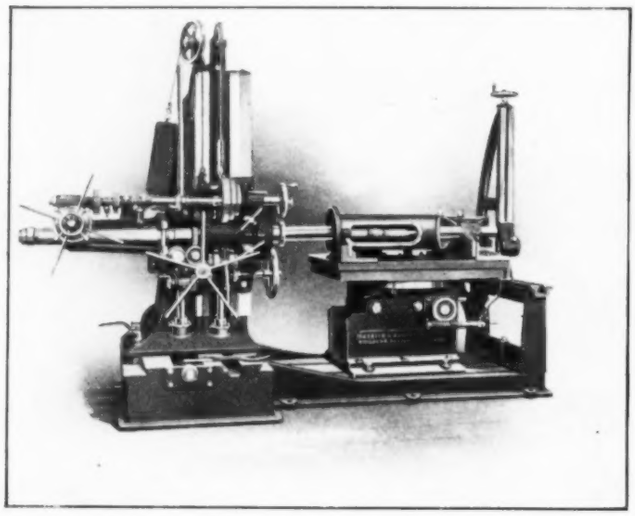


FIG. 1. BORING CYLINDERS

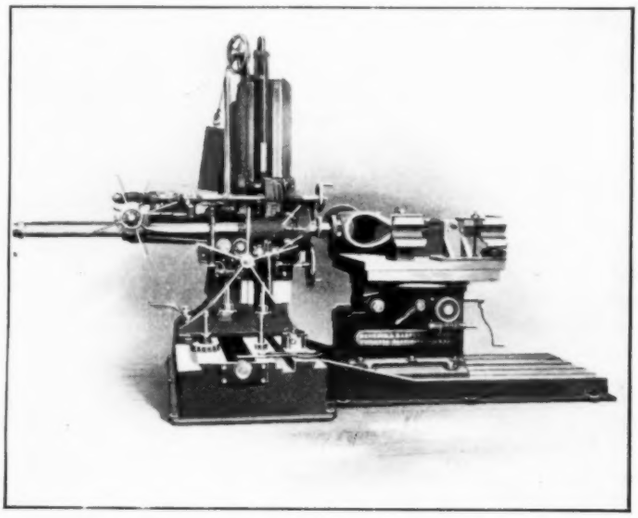


FIG. 2. MILLING SIDES AND EDGES OF FRAME OPENING

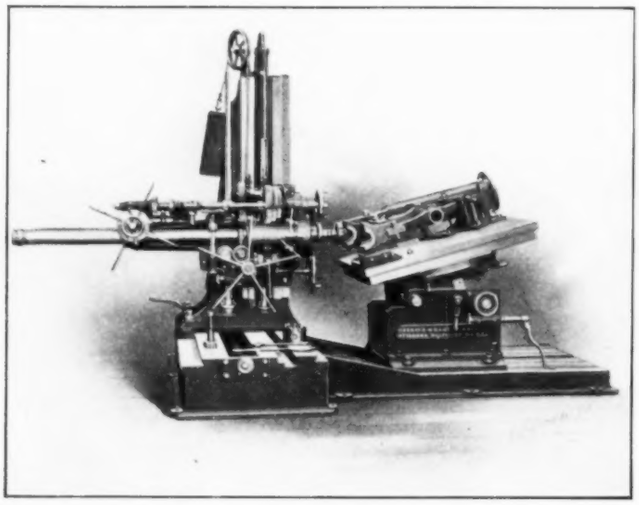


FIG. 3. TILTING THE UNIVERSAL TABLE

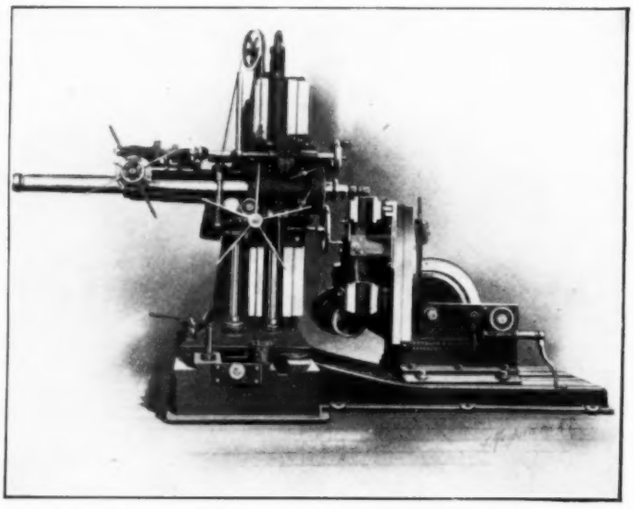


FIG. 4. MILLING THE END OF THE FRAME

Operation of English Patent Law

By an English Patent Attorney

American manufacturers must take steps to protect their inventions against possible revocation of the patents issued therefor, and are now prohibited from entering into restrictive covenants.

Effect of these provisions on American machinery is not definitely known as yet.

Having regard to the enormous quantity of American machinery which pours into England every year it is obvious that American inventors must be closely affected by the law of patents, as it is applied in England.

It is proposed in this article to draw attention to some points of English patent law which chiefly concern the manufacturer in the United States who is considering whether or not he should obtain protection in England. Incidentally, it is proposed to consider whether or not, and under what conditions, it is allowable for an American inventor to send his machines to England and allow them to be used in that country subject to restrictive conditions.

Provision for Revocation.

It should be observed in the first place that nowadays it is essential for the owner of an English patent to work his patent in that country. By an act which was passed in 1907, it was provided that the fact that an invention, which has been patented in England for four or more years, is worked exclusively or mainly outside the United Kingdom will be ground for revocation, and anyone may apply to the comptroller to have it revoked on that ground. Upon such an application being made, the comptroller will institute an inquiry. If, as the result of his inquiry, he is satisfied that the complaint is justified, it will then lie with the patentee to prove that the invention is worked to an adequate extent in the United Kingdom, or give satisfactory reasons for his default. In the absence of such proof or explanation, the comptroller may make an order revoking the patent forthwith, or contingently upon the patentee's failure to amend his default within a certain specified time. If the comptroller takes the latter course, and the invention is still not being worked to an adequate extent at the end of the specified period, the comptroller may, on satisfactory reasons being given, extend the period of grace for another twelve months, but no further.

It is clear that a patent which might be revoked in this manner would have little or no commercial value, particularly having regard to the fact that any trade rival may set the law in motion. Thus any person interested may present a petition to the board of trade, alleging that the reasonable requirements of the public, with respect to a patented invention, have not been satisfied, and praying for the grant of a compulsory license, or, in the alternative, the revocation of the patent. "Any person interested" denotes a person whose commercial interests are prejudiced by the patentee's default.

If the good offices of the board of trade fail to bring about a settlement between the parties, and the petitioner appears to have a fair cause of complaint, the petition will be referred to the court for adjudication. The court may make an order for compulsory license or revocation, according to the requirements of the case.

In order to comply with the terms of the international convention (to which both England and the United States are parties), it is stipulated that no order of revocation shall be made before the expiration of three years from the date of the patent or if the patentee gives satisfactory reasons for his default.

Besides the patentee, all persons claiming an interest in the patent, as exclusive or otherwise, should be made parties to the proceedings.

Points Determining Failure to Work a Patent

The reasonable requirements of the British public are deemed not to have been satisfied if, by reason of the default of the patentee to work his invention to an adequate extent, any existing trade or industry or the establishment of any new trade or industry in the United Kingdom is unfairly prejudiced or the demand for the patented article is not reasonably met. A patentee is considered not to be working his invention in the required manner if he refuses

1. To manufacture the patented article to an adequate extent and supply it on reasonable terms.
2. To supply on reasonable terms any parts of the patented article which are necessary for its efficient working.
3. To carry on the patented process to an adequate extent.
4. To grant licenses on reasonable terms.

Or if

5. He has attached such conditions, either before or after the passing of the act, to the purchase, hire or use of the patented invention as to unfairly prejudice any trade in the United Kingdom.

The petitioner has still a heavy task before him. To prove that the needs of the public, that is, the consuming public, are not adequately met, seems to open up an almost boundless inquiry. To prove that the patentee's default is prejudicial to some particular section of the manufacturing public, though less indefinite, presents a sufficiently arduous task to deter any but the most pertinacious and public spirited.

American Manufacturers Must Protect Their Inventions in England

Enough has been said to show that an American owning an English patent must take steps to work his invention in that country, or he may lose the advantage of protection, and all the money which he spends at the English Patent Office may be thrown away. Several cases have already come before the courts in which persons foreign to England have been deprived of their patents.

In one case (re *Hatscheks Patent*, 25 T. L. R. 457) the judge to whom the duty of administering this act is intrusted, made some of its more obscure provisions quite plain. He pointed out that the act is meant to hit any abuse of a monopoly, the object or result of which is to benefit foreigners at the expense of the traders within the United Kingdom. If a patented article is manufactured in the United Kingdom to as great an extent as can be reasonably expected having regard to the industrial development of other countries, no presumption against the patentee arises. The word "mainly" is used in close connection with and as an alternative to the word "exclusively," and having regard to that fact a process or article cannot be said to be mainly carried on or manufactured abroad merely because it is carried on or manufactured abroad to a somewhat greater extent than within the United Kingdom. The subsection institutes a comparison between the extent to which the article or process, the subject of the patent, is manufactured or carried on in this country and the extent to which it is manufactured or carried on abroad, whether the articles so manufactured are or are not imported into this country. No reasons given by the patentee can be considered satisfactory which do not account for the inadequacy of the extent to which the patented article is manufactured, or the patented process is carried on, in this country by causes operating irrespective of any abuse of monopoly granted by the patent. The demand and supply in this country are to be considered, though they are not the only facts to be considered on the question of adequacy.

Restrictive Covenants

The next important branch of English patent law which is of particular interest to American manufacturers is that relating to restrictive covenants. What, it may be asked, is a "restrictive covenant?" Ask any English boot [shoe] manufacturer who has had to use American boot machinery and you will not be long in ignorance. In the past, American manufacturers who have had control of important types of machinery which are almost indispensable to the English boot trade have been in the habit of allowing English manufacturers to use them only on onerous conditions. Such conditions might include a stipulation that none but the lessor's machines shall be used in a particular mill. According to the common law of England, an agreement of this kind was quite lawful. So, in the case of *United Shoe Machinery Company of Canada* vs. *Brunet* (1909), 25 T. L. R., 442, it appeared that the appellants who were the manufacturers of, and had practically a trade monopoly in certain unpatented machines used for various processes in the manufacture of shoes, leased to the respondents for the term of 20 years, a number of those machines on the terms, *inter alia*, that they should not be used in conjunction with machines not leased to the respondents by the appellants. The appellants also leased to the respondents certain allied machines, whose function was to perform various processes in the manufacture of shoes auxiliary to those performed by the machines first mentioned.

Subsequently, the respondents refused to use the allied machines and used others, which were not leased to them by the appellants, in conjunction with the machines first mentioned. The appellants claimed an injunction to restrain such user and also damages for the breach of contract. The jury found that the appellants had not suffered damage. It was held that the leases of the machines were not void, as being in restraint of trade; and that the appellants were entitled to an injunction, and also to nominal damages for the breach of contract by the respondents.

This being the law, English manufacturers have set themselves to secure its amendment; and the result of their endeavors has been that in 1907 an act was passed which provides that in contracts for the sale or lease of or license to use any article or process protected by a patent restrictive covenants of a certain kind shall be treated as null and void.

Two types of covenant are condemned under this sub-section, viz., covenants, the effect of which is:

(a) To prohibit or restrict the customer from using any article, whether patented or not, or any patented process, supplied or owned by any person other than the patentee or his nominees.

(b) To compel the customer to acquire from the patentee or his nominees anything except what is protected by the patent.

The subsection is not intended to affect any stipulation in a contract prohibiting a person from selling any goods other than those of a particular manufacturer or dealer. Nor will it affect any condition that a patentee may insert in his contract, reserving to himself the sole right to repair the patented article or to supply new parts when required.

It contains a saving clause to the effect that such restrictive conditions shall not be treated as null and void, provided:

(a) The patentee proves that the customer had the option of making the bargain on reasonable terms without such conditions, and

(b) The contract contains a provision enabling the customer to cancel the restrictive conditions by giving three months' notice in writing, and paying the patentee suitable compensation.

The amount of the compensation is to be fixed by an arbitrator appointed by the board of trade.

The insertion of any condition which is made null and void by this subsection may be pleaded as a defense to an action for infringement of the patent to which the contract relates, provided the contract is still in force when the action is brought.

Any contract relating to a license to use a patented invention may, at any time after the expiration of the patent or all the patents concerned, be terminated by either party upon three months' notice in writing, plus the payment of suitable compensation.

We have yet to see what effect this act is going to have on the use of American machinery in England. It is common knowledge, of course, that while these agreements have been successful to a certain degree, the English manufacturer is not a bad hand at "cribbing" ideas from his American cousins. At the risk of infringing patents, which, of course, can only be protected by long and expensive litigation, he manages to produce and make use of machinery "made in England," which closely resembles that which has been imported from the United States. But, as America is always evolving new labor-saving machinery, it is possible that the meaning of these restrictive covenants will soon have to be considered once again.

Spiral Gears on the Slide Rule

By Thomas Vaughn

A simple method of obtaining close approximate dimensions for spiral gears of the slide rule, avoiding the necessity of numerous preliminary calculations.

As it has been many times pointed out, there is nothing especially difficult about the calculation of spiral gears, but for the fact that a fractional number of teeth is generally the result of the first calculation. And it is necessary to adjust either the diameters or the angles a great many times to suit the pitch of cutter, which is the normal pitch. There seems to be no direct solution to this problem; therefore much time may be saved by making the preliminary calculations on the slide rule. In fact, a skilled operator can often obtain all necessary dimensions with sufficient accuracy, and can always come so close that any error may be taken care of in the cutting of the teeth. When allowing an error of this sort the normal pitch should be greater, rather than less than the pitch of the cutter. For when the pitch of the cutter is greater than the normal pitch, the thickness of tooth will be obtained before we reach the proper depth. Even without allowing this error the final solution will be comparatively simple after the slide-rule calculations are made.

The first step is to determine provisional pitch diameters, as follows: Scales *A* and *B* are used.

A Set cotangent driver angle × ratio } { find pitch diameter follower
B over 1 } { over pitch diameter driver (1)

That is, set the value of the cotangent of the desired spiral angle on *A* over 1 on scale *B*, and find the pitch diameter of the follower over the pitch diameter of the driver on the same scales, to add up to the required center distances. Next find the circular pitch of the driver, setting 2.

A Set cosine driver angle } { under normal circular pitch
B over 1 } { find circular pitch of driver (2)

The last move in the preliminary solution is to find the number of teeth that corresponds to this circular pitch, setting 3.

A Under W } { find provisional number of teeth
B set circular pitch } { over pitch diameter (3)

If the number of teeth so found is not a whole number, the center distance must be changed or a new angle must be selected and another trial made. With the slide rule, however, this operation is repeated so quickly, that with a little practice the operator can quickly determine what a change in the angle means in the number of teeth, and a whole number of

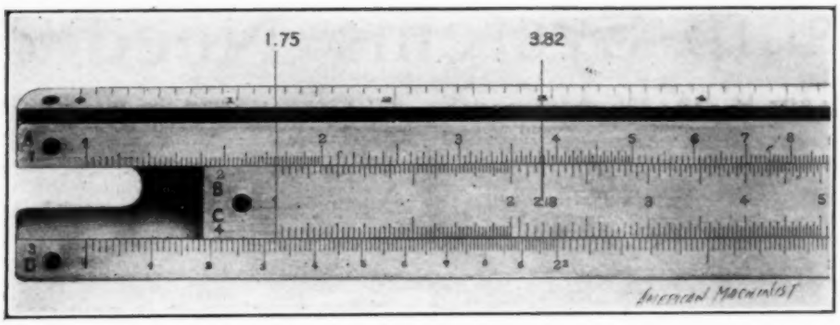


FIG. 1. FIRST SETTING, FINDING PRELIMINARY PITCH DIAMETERS

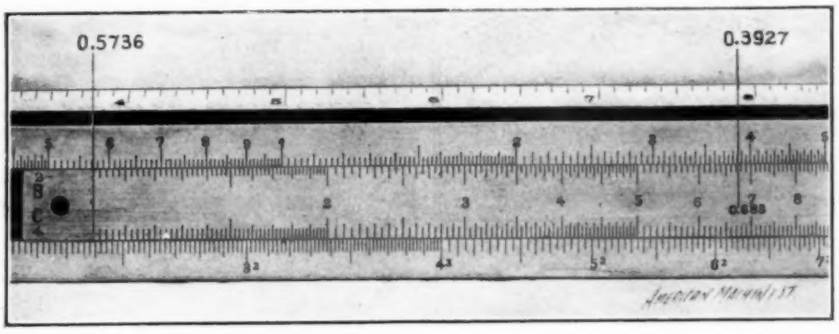


FIG. 2. SECOND SETTING, CIRCULAR PITCH

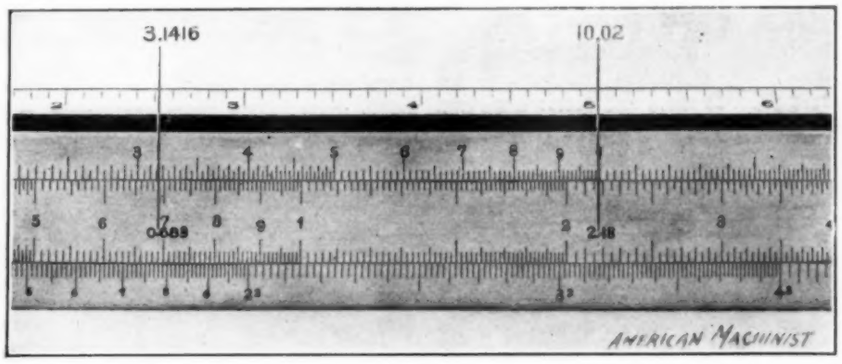


FIG. 3. THIRD SETTING, PRELIMINARY NUMBER OF TEETH

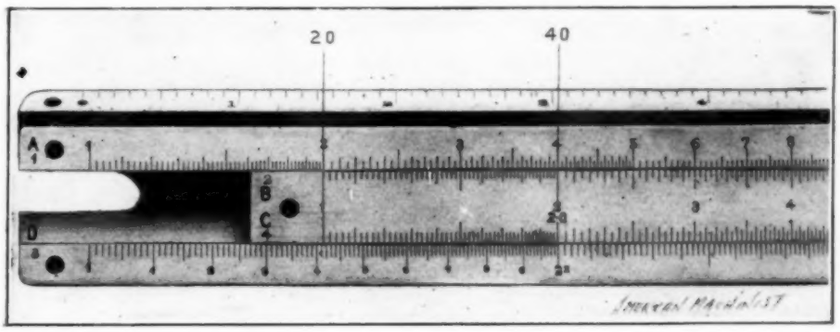


FIG. 4. CHECKING THE PITCH DIAMETERS

teeth are soon determined. This number of teeth multiplied by the ratio of the drive will give the number of teeth in the follower. The angle of the follower is the opposite or complement of the angle of the driver. The balance of the calculations are simple enough and need not be repeated here.

AN EXAMPLE

Center distance 3 inches; ratio, 2½ to 1; normal pitch, 8; (0.3927 inch circular pitch) 3 inches center distance. It has been found that 55 degrees is a very efficient angle for the driver. This angle therefore is assumed. Cotangent of 55 degrees equals 0.7002; cosine equals 0.5736. Ratio times cotangent equals $2\frac{1}{2} \times 0.7002 = 1.7501$.

To find the preliminary pitch diameters, the first setting of the slide rule would be as per setting 1. See Fig. 1. From this it is found that the preliminary pitch diameter of the driver will be 2.18 inches, and of the follower 3.82 inches. The circular pitch of the driver is then found by setting 2. See Fig. 2.

The circular pitch being found to be 0.683, the preliminary number of teeth is found according to setting 3, as shown in Fig. 3. This is shown to be slightly over 10 teeth. By calculation the actual number is found to be 10.02. In this case the error in the normal pitch would not be noticeable, if 10 teeth are used, and no alteration is required in the diameters or angles. The number of teeth in the follower would be 25. The angle of follower would be 35 degrees.

Suppose the number of teeth, pitch diameters and the normal pitch have been asumed, the problem being to determine the spiral angles. In this case we would proceed to find the circular pitch by setting 3, asuming the number of teeth in the driver. The cosine of the angle of driver would then be found by the second setting. The first setting of the slide rule proving our calculations. Or if the assumed diameters were correct, the pitch diameter of the follower would be over the pitch diameter in the driver. If the assumed diameters are not found opposite each other, another trial must be made, shifting the number of teeth, pitch diameters or both.

FINAL SOLUTION

Pitch diameter of driver, 2 inches; pitch diameter of follower, 4 inches, 8 diametral pich.

According to the first setting, the circular pitch is found to be 0.628 inch, according to the second setting, the angle of driver to be 51 degrees 20 minutes The cotangent of 51 degrees 20 minutes is 0.8002; the ratio of drive 2½ to 1, $0.8002 \times 2\frac{1}{2} = 2.00005$. This last setting (No. 1) is shown in Fig. 4, 2½ times the cotangent of the angle of the driver being set over 1, the pitch diameter of follower is found over the pitch diameter of driver, which proves the original assumption to be correct.

Apprenticeship Systems Needed

By B. M. W. Hanson*

Demand for skilled labor has exceeded the supply, forcing the use of handy mne.

Apprentices make the best men even in special manufacturing.

Shops should be made attractive to American boys graduating from the schools and should pay higher wages than usually offered.

Drawbacks of Trade Schools.

It pays to produce a skilled mechanic and pay him all he is worth when he gets through his apprenticeship.

*Works manager, Pratt & Whitney Company.

NOTE—Address before the Hartford Manufacturers Association.

During the rapid growth of the industries of the world, and in the United States particularly, where the manufacture of articles has become more and more in demand and competition in the manufacture of these articles has become more keen, it has been very difficult for the various manufacturers to adjust the manufacturing conditions.

There has been a great demand for machinery which will do work well and cheaply, and in the United States in particular wonderful progress has been made in this line. After the manufacturers and engineers have succeeded in bringing out machinery which has proved successful, the next problem has been how to meet the demand of these machines; that is, first to manufacture them fast enough and well enough, and afterward to see that these machines perform their duty in the shops of the customers where they are used. Very often a machine will work finely in the shop of the maker, but in the shop of the user there will be all kinds of trouble, which, in most cases, is due to ignorance on the part of the operator.

The demand on machinery has been far greater than was possible to produce by the skilled labor available, so that the manufacturer has hired anything he could get in what are called handy men, help to produce this machinery and the user of the machinery has done the same thing; he has put a handy man to run the machine.

APPRENTICES MAKE THE BEST MEN

Some manufacturers think they have discovered a way of getting cheap help; they think that the handy man in a short time will do the work as well as a slowly produced journeyman, and I dare say in some instances bright men have taken to this new work very readily and have become very good workmen; still, I believe, as a class, the mechanic who has served his apprenticeship is the superior man.

Some manufacturers have realized the importance of having an apprentice system, and many manufacturers advocate trade schools. There does not seem to be any unity of action throughout the country to produce more mechanics in a systematic way, and too little earnest thought has been given to make the machine shops in particular attractive to the American educated boy. One of the chief reasons I believe, is that the wages offered to an apprentice boy under modern conditions is entirely too low, and we often get our labor supply from the emigrant office and the street instead of from the graduating class of the American schools.

The mechanical development of this or any other country depends in most part upon the intellect of the workers and the mechanical industries should avail themselves as much as possible of the educated boy, their education being paid for by the mechanical manufacturers as much as by any other citizen of the country. If we could increase the number of intelligent mechanics, we would produce more and better work and our machines would produce better and a larger quantity of work, and they would last longer in our customers' shops if they had intelligent help to handle them.

DRAWBACKS OF TRADE SCHOOLS

The trade school may be of some use, but as a rule, trade schools would only be able to teach the boys how to make a piece of machinery; they will never teach him how to make it quickly, neither will they be able to teach him the most uptodate methods. They will not be able to teach him the value of time, of jigs, gages and fixtures as there would not be enough pieces made in a trade school to make the boy fully realize the value of such tools. Neither could there be the diversity of machinery used in a trade school as in a machine shop. Training schools, as a rule, have engine lathes, universal milling machines, grinders and such machines as are used in tool rooms. In real manufacturing these machines are in the minority. The best trade school in my opinion is the shop itself, where the boy is all the time coached to make the work well, fast, and is also shown on what style of machine the work can be produced in the best and fastest manner; he is also surrounded by the more skilled journeymen. In addition to this, if sufficient incentive is given to the boy, he feels that he is actually making something useful, for which he receives something useful to help himself along.

An apprentice boy makes by far the steadiest workman; he is more apt to stay in the shop in which he is brought up; he generally has his home and friends in the town in which he is working, and associates himself with the surroundings of the place, and as a rule, he hates to break away. If he is properly used he will regard the shop as partly his home. The more we have of this class of help, the less we will have of the floating element. We are now using too many low-grade emigrants and poorly trained natives, who take no pride in citizenship and have no ties to the town in which they live, and very seldom take any pride in the welfare and reputation of the shop in which they work.

PAYS TO PRODUCE SKILLED MECHANICS.

I believe the Hartford Manufacturers' Association is doing a great deal of good in many directions, but to my mind nothing would be of more importance to all concerned than to make Hartford the producer of the best mechanical skill available. It will help the manufacturers who are here now and insure expansion of their business. It will also induce other manufacturers to make their home here. The more intelligent our workmen are, the less trouble they will give us. It is the floating element which causes trouble. The really skilled mechanic wants to rise on his own ability and when he sees that the manufacturer gives him the opportunity to better himself, by showing individual effort, he is apt to become a persistent and loyal member of the organization under which he is working. In no place, to my knowledge are there any better schools for making mechanics than in the shops of Hartford. To my mind it is entirely the fault of the manufacturer that he does not select the right material to obtain this high-grade help.

I believe that even in special manufacturing, such as typewriters, screw making, etc., an apprentice system could be introduced that would produce far better results than the breaking in of handy men. In fact, I do not know of anything being manufactured that could not be done far better by young men of good schooling than by men of questionable education who have worked at different odd jobs. An apprentice system would not necessarily debar a handy man from advancing in the shop when he has proved his ability; in fact, it is

the intelligent men that we want, and any system which will give a chance to intelligent men will be the right one.

Pay a Graduate What He Is Worth

In Pratt & Whitney shops today we have upward of 70 apprentices, and we have lately increased their compensation and have also given them a chance to do piece work. After serving their time we pay them $100 bonus, and our aim is that after an apprentice boy has served his time, we do everything to retain his services as a journeyman and pay him according to his ability. If he can do work for which we pay $3 per day to a journeyman, we will pay him the same. If he does work for which we pay $3.75 per day, we intend to pay him the same. Of course, we also take into consideration his habits and steadiness. I believe that merits only should determine a man's wages. A man's age is only a factor when it improves his ability, and if a young man has the same ability as an old man, that is, he has reached a high point of efficiency at a younger age than other men, it is his good fortune and he should not be deprived of this advantage because of his age.

I, for one, would be very pleased to see the manufacturers of Hartford get together and try to introduce an apprentice system suitable to the various conditions which arise in the different manufacturing establishments, always bearing in mind to give the opportunity to the best educated boy, and making the incentive good enough to reach this class of boys, and in a few years I am sure it will prove a great boon to the manufacturers and citizens of Hartford.

Large Pit Lathe in Mesta Shop

Editorial Correspondence

A 32-foot pit lathe capable of turning a face width of 8 feet and weighing 850,000 pounds.

A massive machine designed to accommodate work of unusual dimensions.

Various interesting features of design and construction.

Pittsburg is rightly looked upon as the home of large machine tools and heavy machine work. Some of the largest machine tools in use in this district have been developed in the shops where they are at work. One of the most recent of these is a 32-foot pit lathe designed and built by the Mesta Machine Company, of Homestead, Penn. This machine is well shown by the three halftones, Figs. 1, 2 and 3.

In capacity this lathe can swing 32 feet and turn a face width of 8 feet. It is massive in design and its weight totals 350,000 pounds, or 175 tons.

The Drive

The drive is from a 30-horsepower, 220-volt, variable-speed, 4-to-1-ratio, direct-current, Westinghouse motor. See Fig. 2.

On the end of the motor shaft is a rawhide pinion meshing with a gear on the first intermediate shaft. On this shaft is a sliding quill carrying two gears that can be made to mesh at will with mating gears carried on a quill on the face-plate pinion shaft. A pinion on this second quill meshes with a gear on the second intermediate shaft seen next to the hollow end of the spindle in Fig. 2. A second gear on this second intermediate shaft meshes with a large gear on the face-plate pinion shaft and completes the drive. Thus there are a fast and a slow speed with only one sliding member, the short quill carrying two gears on the first intermediate shaft. The ratio of these two speeds is 2 to 1.

As we have stated above, the motor is variable speed with a ratio of 4 to 1 and shaft speeds from 250 to 1000 revolutions per minute. Within this range there are 16 motor speeds.

The corresponding face-plate speeds range from one revolution in five minutes to ten revolutions per minute, or a ratio of 50 to 1 between the slowest and fastest.

The starting switch and motor con-

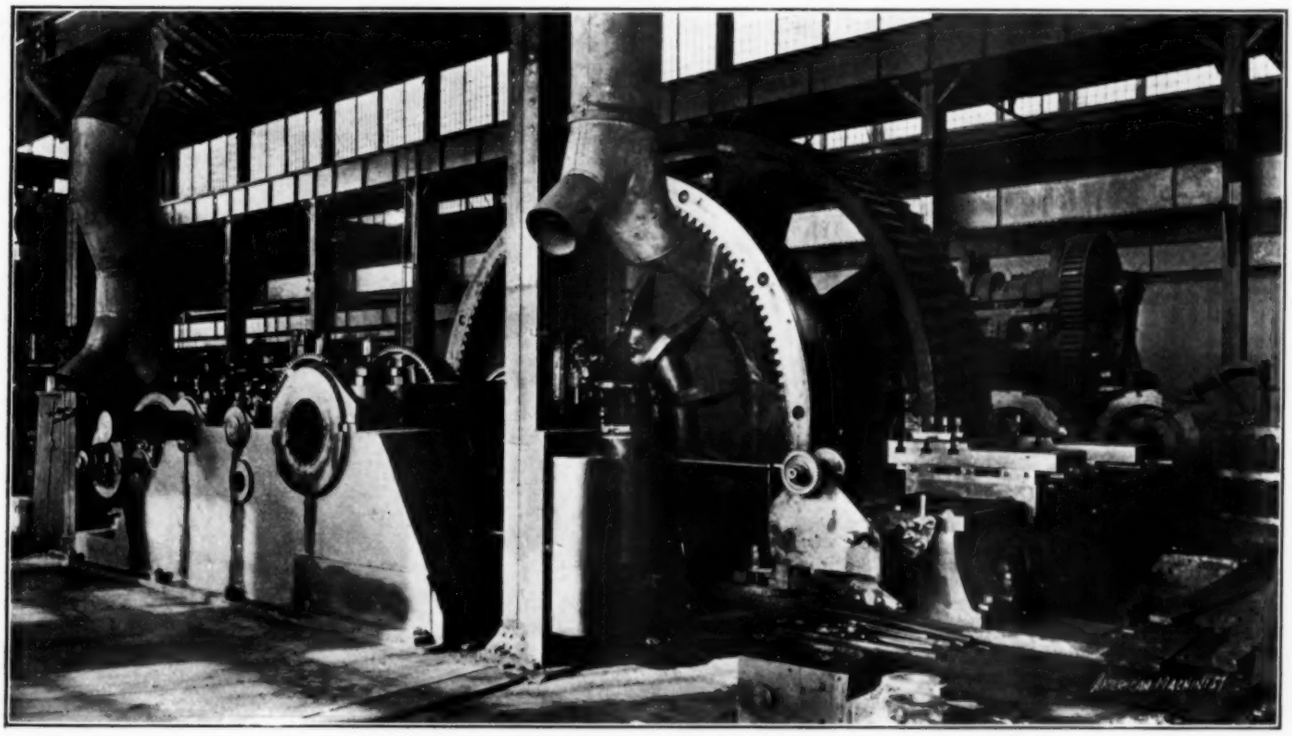


Fig. 1. New 32-foot Pit Lathe of the Mesta Machine Company

troller are best seen in Fig. 1, where they are shown located on the interior column near the lathe.

The Spindle

The spindle is hollow, having a 16-inch finished hole designed to take a boring bar to be driven from the extension of the face-plate pinion shaft. The outer bearing of the spindle is 24 inches long; the journal is 24 inches in diameter and the bearing is babbitt lined. The spindle bearing next to the face plate has a length of 30 inches; the journal is 30 inches in diameter and the bearing linings are bronze.

The face plate is 14 feet in diameter as well as longitudinal feed.

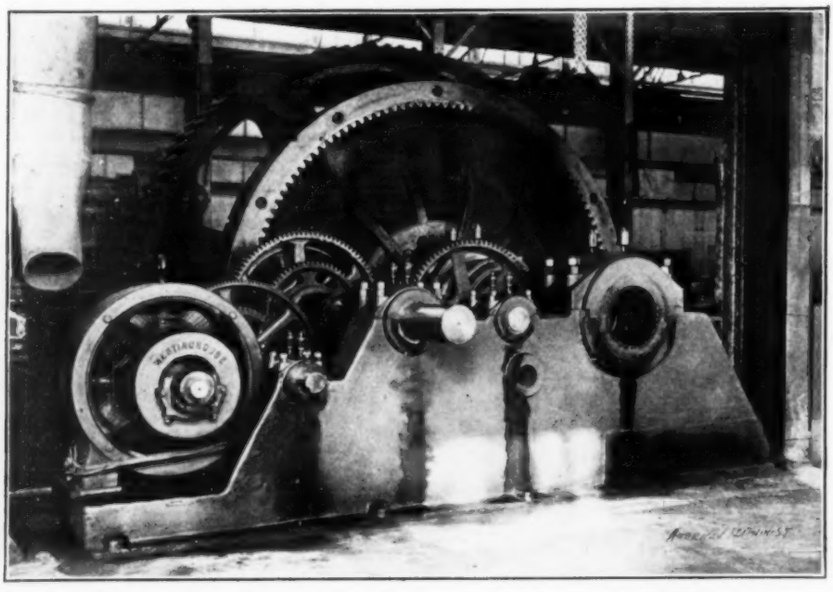


Fig. 2. Driving Motor and Gearing of the Large Pit Lathe

with a face width of 17½ inches and its internal gear is 12 feet 6 inches pitch diameter, 10 inches face, 1 diametrical pitch.

When used for turning a mandrel 15¼ inches in diameter is fitted and bolted to the face plate and supported in a heavy out-board pedestal. See the right-hand of Fig. 3. In order to handle work of different bores, bushings are provided to bush down to the mandrel diameter.

Tool Blocks and Feed

The rail carrying the two tool blocks is of massive girder construction—best seen in Fig. 3. The slides are carried on V-ways; each has its own feed screw and its accompanying tool-box swivels upon it. All of this construction is so plainly shown by Fig. 3 as hardly to need description.

The feeding mechanism is not completely shown in any of these illustrations. The original designs call for a quick-change geared feed box, but in order to get the tool into use at once, another arrangement has been applied. A ring gear has been bolted to the spindle just behind the main bearing; a small part of it can be seen in Fig. 1 at the left of the interior column having the motor controlling device. A short horizontal shaft is driven from this gear through a spur pinion, and this in turn drives a long, universal jointed rod through bevel gears. This rod in turn drives a short shaft carried on a bracket on the left-hand end of the tool block rail and from this through suitable gearing the cross-feed screws are driven. The usual geared reversing device is provided for both screws.

When this part of the lathe is finished, it will be provided with power cross feed

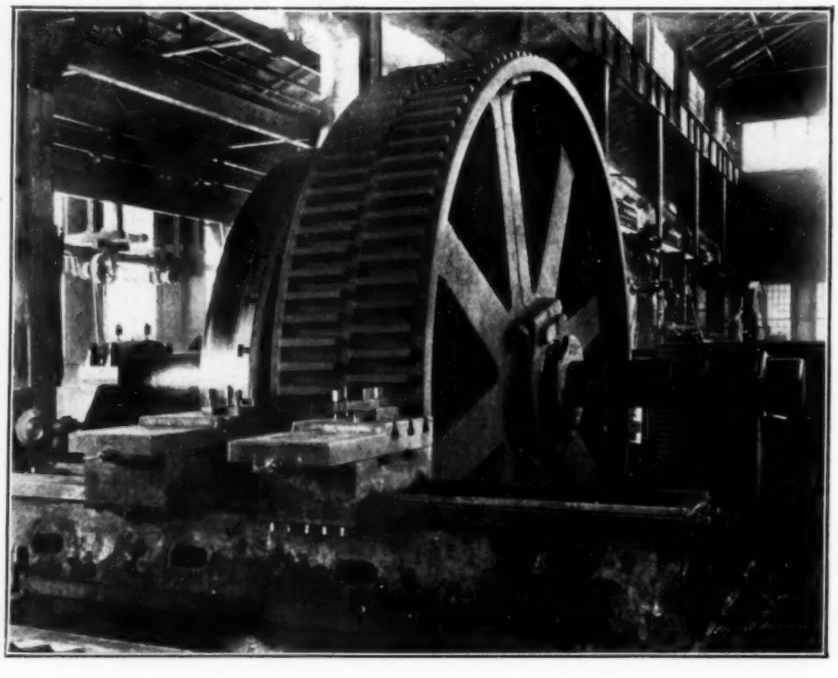


Fig. 3. Tool Blocks and Outboard Bearings for the Arbor of the Large Pit Lathe

Fig. 4 is presented to show some of the first work done on this tool. It is unusual, to say the least, to see such a collection of rope sheaves grouped together so that they can enter a single photograph.

As indicating the capacity of the machine for handling work, it is stated that it is very difficult to get high-speed steel that will stand up under the cuts that the machine can drive with ease. The first month's work gave a carload of cast iron and steel turnings—60,000 pounds.

Spot welding, the latest development in electric-welding processes, which is coming into extensive use for a great variety of work, has only one feature in common with ordinary butt welding, the formation of molecular union between semi-fluid metals by means of mechanical pressure. In general, electric butt welding is applicable to joining the ends of bars, rods, forgings, etc. The heating current is approximately evenly distributed over the entire area of the abutting surfaces; when a welding temperature is reached the two pieces are forced together endwise. Spot welding, on the other hand, is limited to the welding of overlapped sheets with comparatively large areas of metal in contact. Only a small percentage of the actual contact area is joined, the welding area being confined to one or more distinct "spots." The heating current does not flow across the entire area of the contact surface, but is localized at the spots, while the remainder of the stock remains cold. —*Electrical World.*

Manufacturers' Industrial Report

By E. H. Fish

Some comments on the report of the committee on industrial education presented to the recent annual convention of the National Association of Manufacturers.

The committee on industrial education of the National Association of Manufacturers, possibly mindful of past criticisms, made a change in the authorship of their reports. The one recently presented at the New York meeting is interesting from every standpoint, whether the reader agrees with its conclusions or not. In fact, it is possible to question even the opening statement that the association has during several years past done much to bring the importance of industrial education to the front. No mention is made throughout the report as to whether the committee favors public trade schools or not, yet it must be surmised by every reader that the proposal is for a public-supported school.

Among the points on which general agreement is at least predicted are these: That the average shop is not likely to organize trade-school departments that will give the best results in both skill and schooling; that half the time of the pupil spent under actual shop conditions, but under the care of competent instructors, is sufficient to learn the trade more thoroughly than has ever been done in the past.

Two points are likely to be questioned: One, the prediction that trade-school shops can be run with a smaller percentage of spoiled work or damage to equipment than the average shop; the other that such a shop can be largely self supporting.

To the lay mind it would seem that these two statements are in a way contradictory, inasmuch as the first necessitates the employment of a large number of instructors to a given number of students, in order that they may be under constant supervision. The second implies both high productivity and low overhead charges, though the term "largely self supporting" may mean much or little, according to the reader's point of view.

A very strong point is scored in the statement that as good or better material for skilled workmen may be found lower down the social scale than has hitherto been expected. When we consider the obscure origin of many of the greatest men of history, it would seem that the lower social strata must inevitably contain many boys whose minds are susceptible of a high degree of cultivation, whether the result be what is usually termed a cultured mind or not. The question of what is best for the world, a number of cultured fools or an equal number of unrefined workers, is one that can best be solved by giving it up as too difficult a task and by setting to work to get our colleges to turn out a larger percentage of cultured workers, and in some way to bring up out of the lower walks of civilization as large a number of workers plus whatever culture they may be able to absorb as possible. As is intimated in the report, there is likely to be as great culture in the serious study of cause and effect in mechanical pursuits as in the chasing down of a Greek root.

Training the Boy Who Must Earn His Own Living

So much for the training of the boy fresh from school. How about the boy who must earn his own way?

Evening schools, extension schools and part-time schools are referred to, but only referred to as being valuable for the advancement of those already in the shop. In this particular, the part-time school would have to be the reverse of the Fitchburg plan, where part-time education is offered as a bait to draw boys into the shops from the schools. Whether when offered to those already in the shop, it would be possible to find a class of any size even in a large city who would sacrifice half their pay for the sake of the education is doubtful in view of several trade-school experiences.

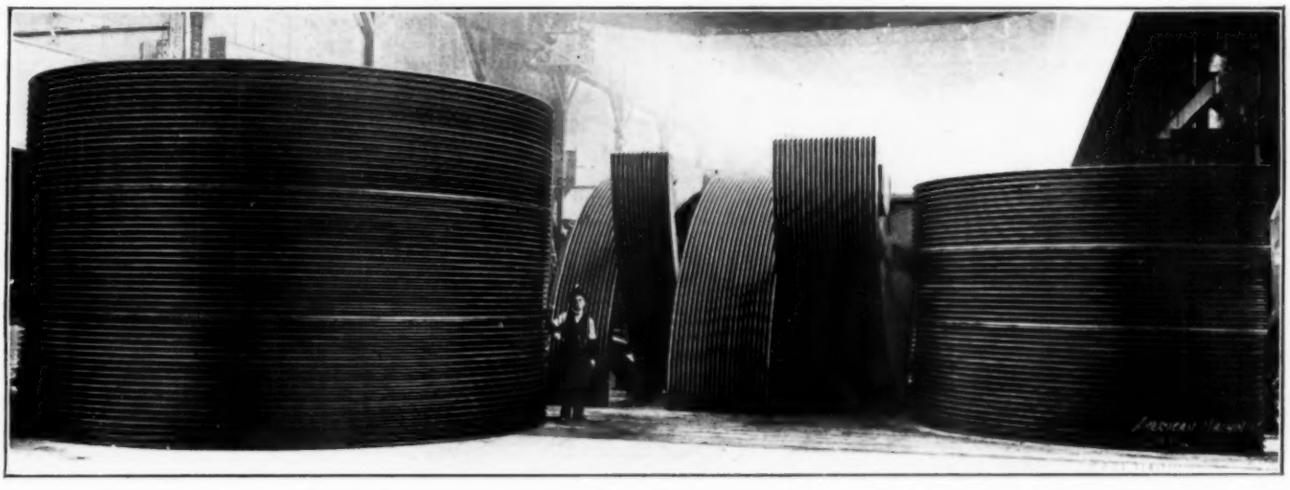


Fig. 4. Some of the First Work Done on the Large Pit Lathe

A new field for the unemployed is opening up with the development of the aëroplane. The following advertisement in a German hotelkeepers' paper is significant.

Wanted—By the Aëronautical Society at Friedrichshafen (Count Zeppelin's company), a capable, experienced head waiter to take full charge of catering arrangements on board an airship. Must not weigh more than 140 pounds.

Hot meals can be served at any moment from a fireless cooker. The first aërial bill of fare will be a curiosity for menu card collectors, and may in time rank in value with rare old postage stamps.

Dies for Forming Bread Pans

By J. A. Hart

These useful household utensils are manufactured in a series of simple operations accomplished with blanking, forming and curling tools in the power press.

Method of constructing the dies, carrying the work through the various operations, putting the wires and handles in place, and attaching the supporting guard strips.

The accompanying sketches illustrate a set of dies for making rectangular roasters or bread pans, with sharp corners, the surplus metal at the corners being folded over the ends. The material is tinplate, and the points claimed for this method are: Cheapness and simplicity of dies, ease of making, and a strong well-shaped pan with handle attached, as in Fig. 1, with no rivets.

Blanking and First Forming Operation

The operations consist of blanking, three forming operations and one wiring operation. The blanking die is of the usual type, a steel ring welded to an iron plate, with a piece set in the center of one end of such length and width as is required, notched out for the handle.

The first forming operation brings the blanks to the shape shown at *A*, Fig. 2. Fig. 3 shows the dies for this operation, a section of both punch and die and a plan of the die being shown. For the sake of clearness, no screws or dowels are shown in this or the other sketches.

The Forming Dies

The dies are of cast iron except for the parts *S*, which are cast steel, hardened. The extreme edge of the blank is given a slight turnover by these steel edges, this being necessary to start the wiring operation easily. The steel pieces are fastened by screws and dowels to the punch, but are made a tight fit for the slots in the die and are merely pressed into place, this being sufficient to hold them. The parts *D* are cast in one length, machined and then cut to the proper lengths. They are fastened by screws and large dowels.

The pins *E* are for locating the blank.

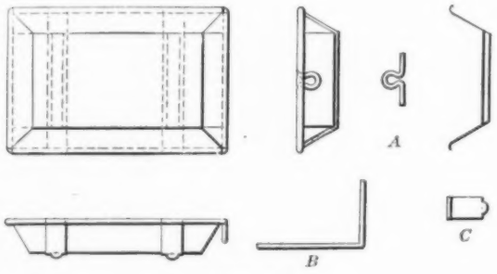


Fig. 1

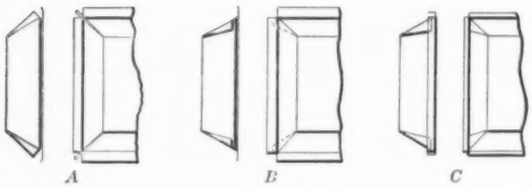


Fig. 2

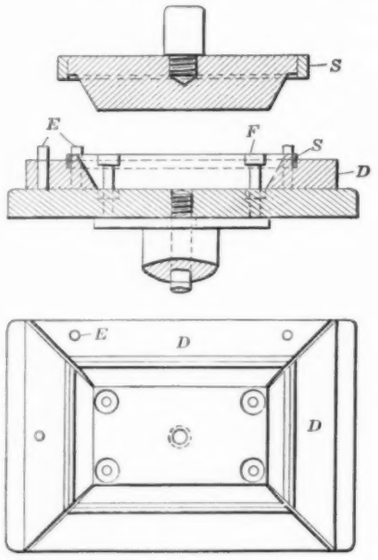


Fig. 3

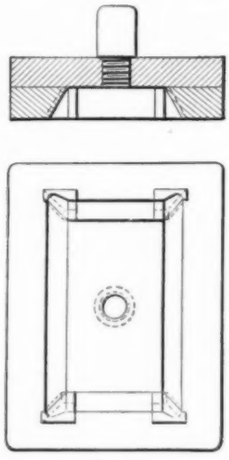


Fig. 4

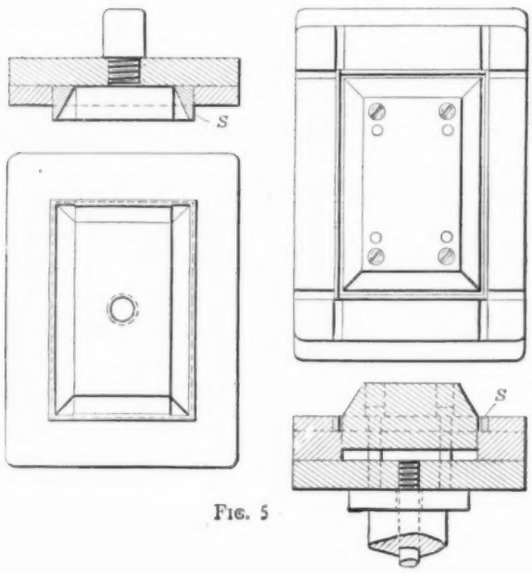


Fig. 5

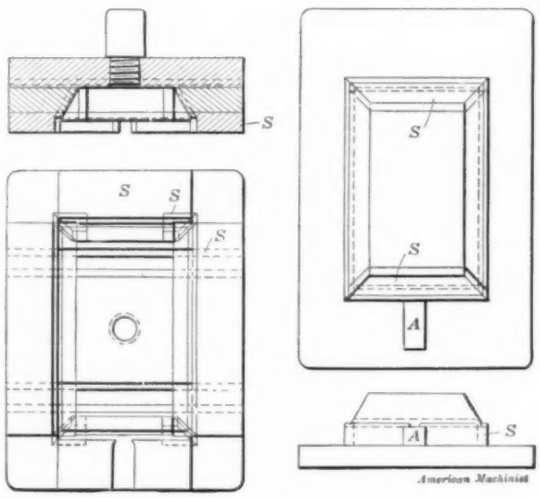


Fig. 6

Dies for Making Rectangular Bread Pans

The four pins *F* perform the double duty of holding the blank in position while forming and raising it out of the die after forming. They are actuated in the usual way by a rubber pad underneath. The surplus stock at the corners goes through the narrow slots between pieces *D*.

Tools for the Second Forming Operation

Fig. 4 shows the female die for the second forming operation. The male member in this and the following operations is fastened to the bolster plate of the press, the female die working with the slide. With this arrangement the male die acts as a guide, centering the blanks. The male die for this operation is not shown as it is a plain casting machined to the size and shape of the inside of the blank. The female die is composed of a cast-iron ring screwed and doweled to a cast-iron plate. This construction, used on the next operations also, allows of the inside of the ring being machined through, using an angle plate of the required angle on the planer.

There are hardened-steel pieces let into the four corners as indicated. When the die descends on the blank, the surplus metal at the corners of the blank follows the curved surfaces in the die, and is curled around as represented at *B*, Fig. 2.

Other Forming Tools

Fig. 5 shows the dies for the third forming operation, a section and plan of both male and female dies being shown. In this operation the surplus stock at the corners of the blank is flattened down and the edges of the blank are turned up for the wiring operation to follow, as shown at *C*, Fig. 2. The parts marked *S* are of cast steel, hardened, the rest being cast iron.

This die requires a stiff rubber pad underneath to keep the male die in its upper position, till the female die seats the blank firmly upon it, otherwise the edges turned up for wiring are liable to be of varying hights.

The action of the die is clearly shown by the drawing. It will be noticed that the outside faces of the steel pieces in the female die are beveled or undercut slightly. This is to clear the small edge turned over on the blank in the first forming operation.

The Wiring Process

Fig. 6 shows the dies for the wiring operation. A section and plan of the female die, and an elevation and plan of the male die are included. These again are of cast iron except for parts *S* which are of cast steel, hardened.

The blank is laid on the male die and the wires, etc., laid in, and the female die descending curls the stock around the wires. The parallel part of the steel pieces in the female die are made deep enough so that they are down past the blank and in contact with the male die before the curling commences. This insures a correct curl taking place and prevents the stock, which is very thin, from bulging outward.

The slight turnover given to the edges of the stock in the first forming operation gives the curl a good start. This die is made a good fit all over and "irons" the finished pan, making a good square job.

How the Wires Are Used

The wires *B*, Fig. 1, which are tinned, are cut to length and bent at right angles in a simple bending die, which is used for all sizes of wire.

These wires are cut to such lengths, that four are used on each pan, the reason for this being, that if one continuous wire is used, the wire forming is a much more expensive operation, as a small variation in size would ruin the wiring dies, and also, when wired with a continuous wire the finished pan is more liable to have a twist or "wind" in it, which it is almost impossible to take out.

When the wires are in four lengths as shown, the twist can usually be easily taken out and the forming of the wires is a very simple operation. The resulting pan is also very stiff.

Attaching the Flat Strips

The strips *C*, Fig. 1, which are to keep the pan off the hot oven plates and prevent burning of the contents, are attached by the wiring operation. The strips are slipped over the pan and the wires laid in, catching the curled ends of the strips. When the die descends these ends are caught tightly in the wiring. By making the strips a shade short, the wiring stretches them and makes a tight job.

It will be noticed that the female die, Fig. 6, is cut out at both bottom and sides to clear the strips. The strips are sheared to length and width from scrap metal, and formed up in a hand press.

Putting in the Handles

The handles *A*, Fig. 1, are also attached during the wiring operation. They are formed to the shape shown, in a hand bending fixture attached to the bench, and are made of tinned wire, a size smaller in diameter than the wire used for wiring. This difference in diameter allows the handle to move freely when in place. To make room for the handle, two of the wires are cut the required amount shorter.

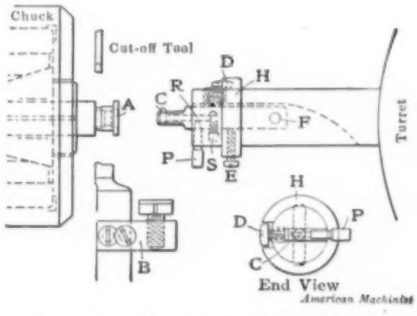
There is a narrow slot cut in the blank wide enough to let the handle in as shown in Fig. 1, and deep enough to let the handle come straight with the pan. When attaching the handle, it is laid with the straight part in the rim of the blank and the ring resting on the pad *A*, Fig. 6. The female die is cut out to clear this pad.

These dies make a good job and work very satisfactorily, the pans coming out sharp and square. Suitable air holes, not shown, are drilled in the dies where required.

A Turret Recessing Tool for a Small Hole

By Alexander Bliden

The clutch blank shown, *A*, made of ⅜-inch cold-rolled steel on a hand-screw machine, has a hole 5/32 inch diameter, the rear portion being slightly enlarged, about 0.01 inch, for clearance. The tool consists of a body, made of ⅝-inch steel rod, slotted to receive the movable cutter holder, fulcrumed at *F*, this holder having a projection *P* for engraving the adjustable screw on the attachment *B* on the front slide forming tool. In operation, after the piece is made in the usual way, and just prior to cutting off, the tool is advanced half the depth of the hole, stopped at a mark on the turret slide, fed into its cut by an additional movement of the front tool, and continued forward to a stop, when the tool is released by the withdrawal of the front slide. The removable cutter *C* is 1/16-



Recessing Tool for a Small Hole

inch wire, held by the pressure of the rod *R*, actuated by the taper-ended screw *S*, which is itself only 0.72 inch diameter. The return spring is held in place by its end being clamped under the head of the screw *D*, while the tool is adjusted for center by the screw *E*, located in a slotted ring *H*, frictionally held on the tool body. On account of the small size of the hole, in the piece being made, the construction appears weak; yet in operation it was quite satisfactory, making two thousand pieces with no attention except sharpening.

According to the *Electrical World* a locker thief was trapped at Brown University by a clever electric alarm. A pocketbook inserted in the jaws of a spring contact, the terminals of which were carried to an alarm in a nearby office, was placed in a trousers pocket and the wires concealed. The removal of the purse closed the circuit and announced the theft, and the thief was caught red-handed.

Letters from Practical Men

Concerning the details of making things in machine shops, from the first sketch to the shipping room.

A letter good enough to print is good enough to pay for. The value is in the idea—not the length of the letter.

Feed Tube for Soap Press

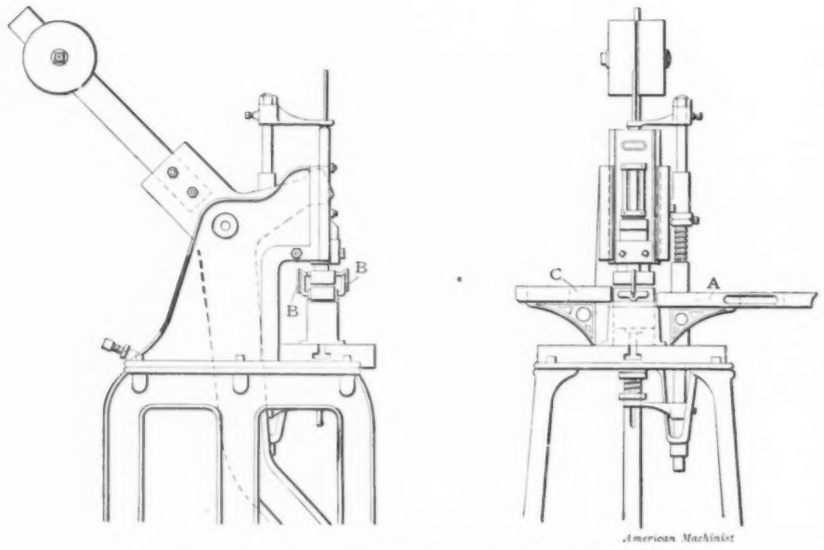
Now and then we hear of boys getting their fingers caught in soap-press dies. I herewith present a scheme that will remedy that evil. The blueprint shows a common foot press seen in all the soap factories. The present practice is to lay the cake of soap on the bottom die, which at this moment is even with the top of the die box. The treadle is depressed, which brings the punch down upon the soap and forces it down into the die box. This gives it its shape and stamps an inscription on the top and bottom of the cake.

The weighted lever seen on top brings the crosshead up, and by means of the connections to the vertical rod on the side and a lifter pin in the die box, it raises the bottom die and cake so that the bottom is again even with the top of the die box, the punch continuing on a little higher, when the finished cake is removed. A good operator can do about one per second.

Now, to facilitate this operation and prevent the fingers from getting caught, I feed the soap to the die through a tube *A*, till it comes up against the ½-inch projection seen at the left side. The cake is stamped in the same way but in coming up it is grabbed by the two spring fingers *B* and raised ½ inch higher so as to bring it in line with the left-hand tube *C*.

It can readily be seen that the next cake feeding in, pushes the finished cake into the left-hand tube. Thus the operator's fingers do not get near the dies.

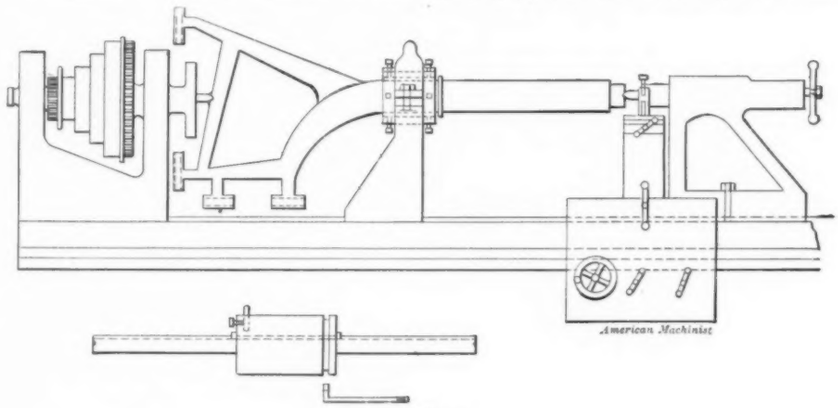
Chicago, Ill. M. JACKER.



FOOT PRESS WITH FEED TUBE FOR SOAP DIE

Turning Drill Press Columns —Boring a Steady Rest

At the plant in which I work we turn the columns of several hundred 20-inch drill frames every year. These drill frames being all in one piece, we put in a steady rest near the top of the column. This rest is bored about 8 inches and is 6 inches through the bearing. All we have to do is to slip a cast-iron ring, ¾ inch thick (made a nice running fit in rest) over the column of the drill, put it in the lathe centers and run the 12 set screws which are in each side of the ring (where it sticks through the steady rest) up to the drill frame nice and snug and we are ready for business. Noticing that the drill columns were not coming out of the lathe round, we found the rest to be worn too big for the ring, so, of course, it had to be bored out and a new ring made to fit. It had, of course, to be bored in place. Having no sliding-head boring bar, we decided to make one. I found a piece of old shafting in the blacksmith shop 3½ inches by 3 feet, which we centered and turned true, next we cut a half-inch keyway in it, a quarter inch deep, to within three inches of either end. Then we cast a piece about 7 inches diameter and 8 inches long, and bored it a sliding fit on the bar and turned it up all over. Then we keyseated the head, put in a half-inch key securely and turned the ends of key up about a half inch each side of boring head, so it could not possibly move. Next we mortised a ¾-inch tool hole about ¾ inch from the extreme end next the lathe head, and put a ½-inch set screw in to hold the tool. To feed the head along the bar, we cut a groove in the end of the head next the dead center, ⅝ inch wide and ⅝ inch deep. In this groove runs a roller of steel which is fixed in the end of an iron piece ⅞x1¼ inches, bent in the shape of an L, the one end of which is in the tool post of the carriage, which feeds the head along the bar. The cuts will make everything plain.



THE WORK

Salem, Ohio. ARTHUR HARWOOD.

Number of Teeth in Milling Cutters

I think J. Butterworth's formula for cutter teeth given at page 616 of the AMERICAN MACHINIST of April 16, 1908, is the most reliable one I have investigated. The formula is as follows:

$$N = \left(\frac{D}{2F} + 10\right) \sqrt{D}.$$

Where N = number of teeth in cutter.
D = diameter of cutter in inches.
F = face of cutter in inches.

I have compared several successful cutters and find that the number of teeth practically coincides with the above formula.

Mr. Butterworth claims the formula to hold good for cutters 1 to 9 inches diameter. I have carried out the table to 12 inches diameter, as I find it just as successful on that diameter.

Erith, Eng. A. W. BOASE.

Diameter of Cutters in Inches	Width of Cutters in Inches												
	1	1½	2	3	4	5	6	7	8	9	10	11	12
1	10	10	10	10	10								
1.5	14	12	12	12	12								
2	16	16	14	14	14	14							
2.5	18	18	16	16	16	16	16	16	16				
3	20	20	18	18	18	18	18	18	18	18	18	18	18
3.5	22	20	20	20	20	20	20	20	20	20	18	18	18
4	24	22	22	22	22	20	20	20	20	20	20	20	20
4.5	26	24	24	22	22	22	22	22	22	22	22	22	22
5	28	26	26	24	24	24	22	22	22	22	22	22	22
5.5	30	28	26	26	24	24	24	24	24	24	24	24	24
6	32	30	28	28	26	26	26	26	26	26	26	26	26
6.5	34	30	30	28	28	26	26	26	26	26	26	26	26
7	36	32	32	30	28	28	28	28	28	28	28	28	28
7.5	38	34	32	30	30	30	28	28	28	28	28	28	28
8	40	36	34	32	32	30	30	30	30	30	30	30	30
8.5	42	38	36	34	32	32	32	30	30	30	30	30	30
9	44	40	36	34	34	32	32	32	32	32	32	32	32
9.5	46	40	38	34	34	34	34	32	32	32	32	32	32
10	48	42	40	36	36	34	34	34	34	34	34	34	32
10.5	50	44	40	38	36	36	36	34	34	34	34	34	34
11	52	46	42	40	38	36	36	36	36	36	34	34	34
11.5	54	46	44	40	38	38	38	36	36	36	36	36	36
12	56	48	44	42	40	38	38	38	38	36	36	36	36

American Machinist

TABLE GIVING NUMBER OF TEETH IN MILLING CUTTERS

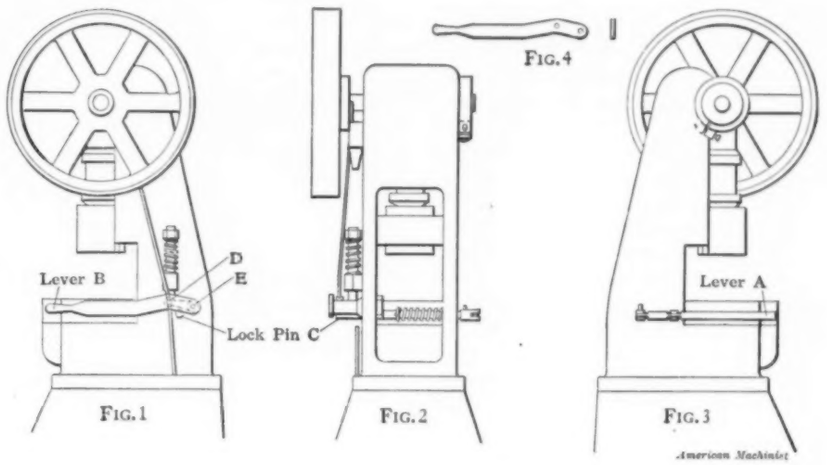
Safety Trip for Punch Presses

Carelessness on the part of punch-press operators has undoubtedly been the cause of a great many accidents, but, aside from this, owing to the nature of punch-press work, the operating is more or less dangerous, especially on forming or second-operation work. This class of work generally requires the operator to place the pieces in the dies with his hands and should the foot come in contact with the trip treadle during this time, the result would be disastrous for the operator. To overcome the danger, the safety trip herewith shown was designed.

In Fig. 1 the general outline of the device is shown as applied to the press and as the sketch will be readily understood, only a brief description will be given. The operating lever *B* can be easily attached, as only a special stud *E* is required for holding it. The foot lever is disconnected by simply loosening the set screw at *D*. The operating lever *B*, shown more clearly in Fig. 4, is fastened on stud *E* and connected to stud *D*. This was the first idea for operating these presses by hand, but it was noticed that some operators would trip the lever *B* with their arms, also leaving one hand free, thereby insuring only partial safety to the operator. To overcome this objection, a second lever *A*, Fig. 3, and lock pin *C*, Figs. 1 and 2, was applied, which necessitated the use of both hands in operating the presses. That is, lock pin *C* must be released with lever *A* before the lever *B* could be operated.

This device is very efficient, easily attached, and can be quickly changed to be operated either by hand or foot. It is giving good service and saving the hands and fingers of the punch-press operators.

Urbana, Ohio. W. F. HOFFMAN.

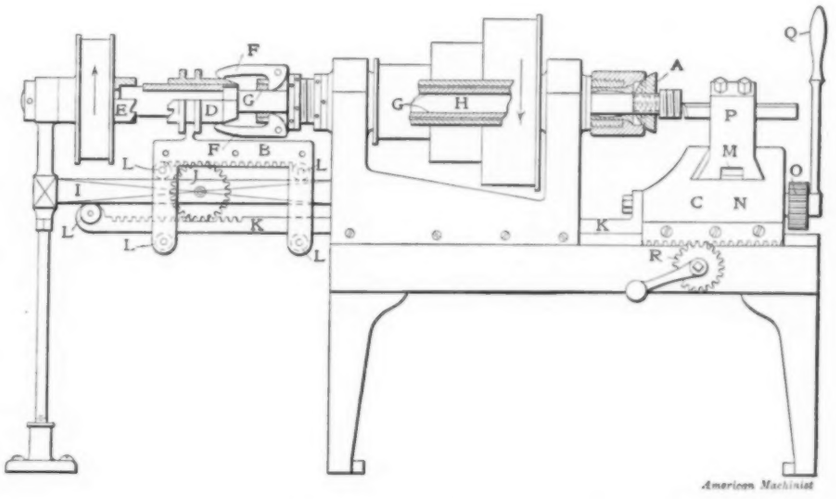


SAFETY TRIP FOR PUNCH PRESSES

A Nut Facing Machine

New features about this machine are the half-ball collar *A*, on which the nut seats without forcing the thread in the nut out of parallel with the thread on the arbor and the clutch *B*, operated by the tool carriage without any extra lever. As the carriage is moved to the right after a nut is faced, it opens the spring chuck, pushes the sleeve *D* against the loose pulley *E*, revolving in the opposite direction, causes a sudden reverse and loosens the nut.

A contrary result is obtained by moving the carriage to the left, the sleeve *D* coming in contact with the fingers *F*, pull back the sleeve *G* and closes the chuck on to spindle *H*, carrying the nut to be faced. *I* is a flat beam slotted to



A NUT-FACING MACHINE

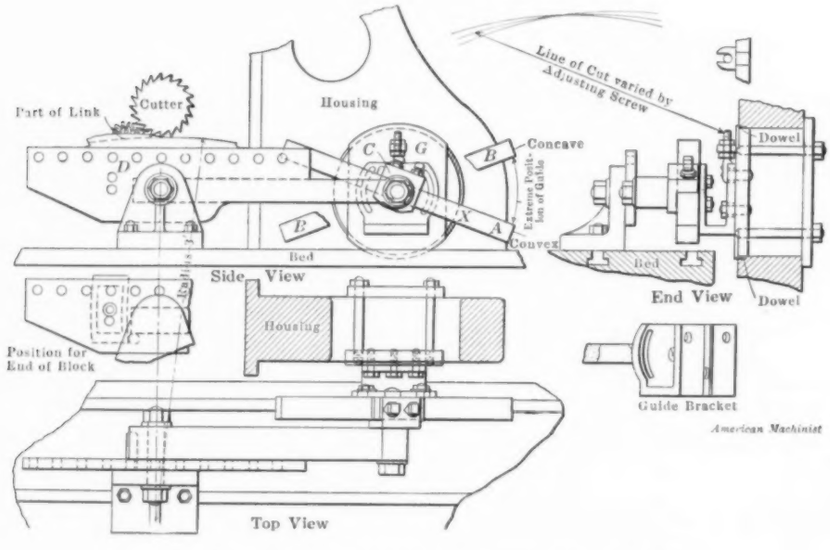
admit the gear *J*, which is set in motion by the rack *K* passing through cone carrier and attached to the carriage *C*. *L L L L L* are rollers to avoid friction on the beam *I* and rack *K*. *M* is a rack fastened to the bottom of the tool post. It is operated by a gear *N*, not shown. *O* is a gear meshing with another one which is fastened to the shaft carrying gear *N*, which moves tool post *P* back and forth.

Montreal, Can. G. A. BEAUDRY.

An Arc Milling Attachment

The line cut shows an arc milling attachment designed by me and applied to a slab milling machine. The device can be used either on convex or concave work. By setting the bar *X* as at *A* convex work is produced and as shown, partly, at *B B* concave work results. The work is pivoted on the fixture at *D* and the sliding block *C* rides on the bar *X* which may be set either horizontal for flat work or at any angle to produce any desired arc. The bar *X* is secured to the bracket *G* which is bolted to one of the housings of the machine or it can be attached to a bracket fastened either to the bed of the machine or to any other stationary part.

Birmingham, Ala. W. B. ODELL.



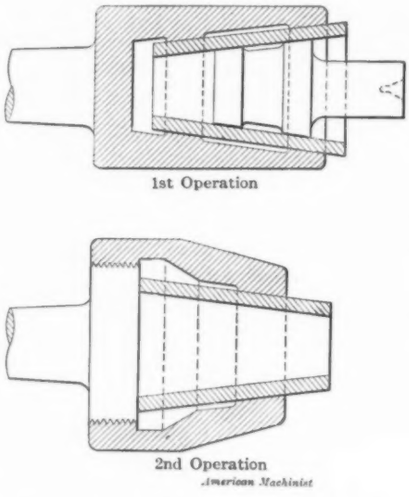
ARC MILLING ATTACHMENT FOR LINKS AND BLOCKS

Chucks for Taper Distance Pieces

The fixtures illustrated in the sketch were made to produce taper distance pieces. These were of cast iron and the two turned faces or ends had to be parallel and correct for length. The first operation consisted in placing them in the bell chuck, adjusting the tailstock center against the false center and skimming the first face. The second operation was that of placing them against the chuck shown, and screwing the cap up until the work was held firmly. This end was then faced to a correct length, a hight gage being used from a faceplate to get the correct length.

The first fixture used was a female center bored to the same taper as the work, and a false center provided with a large hardened center for running on. The second fixture was a chuck with a threaded cap, which pulled the work back on to a true face and held it at the same time. We had tried one or two other ways of doing this job, but this one was the most successful, the work turned out being accurate within the limits allowed.

Covington, England. T. B. COREY.



CHUCKS FOR HOLDING TAPER PIECES

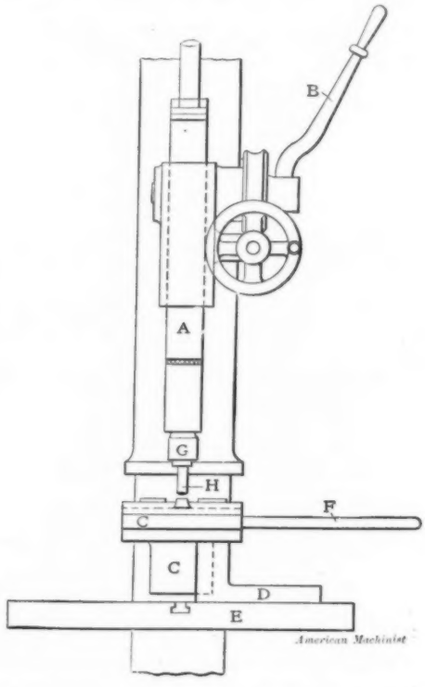
Threading Bolts in an Upright Drill Press

I well remember reading an article in the AMERICAN MACHINIST two or three years ago by A. J. Baker, on a special nut-tapping rig, which he saw used in a shop in the "Black Country," near Birmingham, England, where some of the small shops turn out work at an exceeding cheap rate, with very inexpensive tools.

During the last few years I have often had occasion to visit a shop of this description near Wolverhampton, where expensive tools are out of the question, and many are the makeshifts I have seen there. One particularly has often struck me as being out of the common. As shown in the accompanying illustration, it consists of an old upright drill, which is often used for threading black bolts up to ½ inch diameter, at a speed which would be hard to beat by any other method, and I can testify to the quality of work it produces. In fact, I have never seen a better thread.

In the sketch, *A* shows the spindle sleeve, and *B* the operating lever. *C* is an old die head, of a type often used in England on threading machines. It has three chasers, as shown, and is secured to the angle iron *D* by a strap, the angle iron having a V in the front to allow *C* to fit in without shake. The angle iron is secured to the table *E* by bolts in the usual manner.

F is the lever which opens the threading dies; *G* is a chuck which fits in the drill spindle and has a hexagon hole



THREADING BOLTS IN THE DRILL PRESS

drifted in to fit the heads of the screws or bolts which it is desired to thread. The operator closes the dies with the lever *F*, inserts the work *H* in the chuck, pulls the lever *B* down, and forces the work into the dies. When the work is threaded the required distance, he opens the dies with lever *F*, and the bolt drops out of the chuck and through the hollow shank in *C*, and thus the work goes on without stopping the machine.

Dudley, Eng. J. HARVEY.

Different Ways of Making a Piece on the Automatic Screw Machine

No doubt there are many ways of making the piece shown in Fig. 1. This is of cold-rolled stock 3/16 inch diameter,

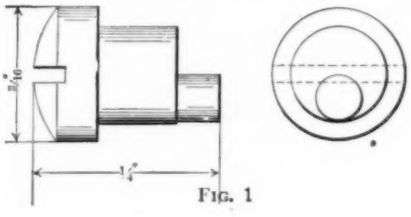


FIG. 1

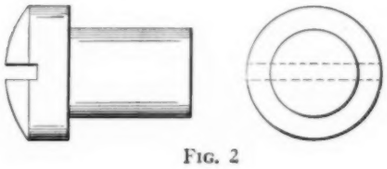


FIG. 2

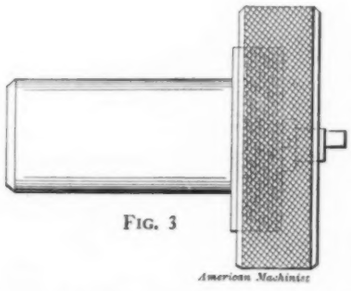


FIG. 3

THE WORK (ENLARGED) AND THE SECOND OPERATION CHUCK

and ¼ inch long over all. We started in to make it the most convenient way at the time, with as few new tools as possible. First we selected a set of cams that would do the job on a No. 00 Brown & Sharpe automatic machine. With regular tools we were able to produce 2300 as per Fig. 2 in ten hours. This so far looked reasonable as it included slotting the head. To turn the eccentric end we had to make a special holder for the hand machine as shown in Fig. 3. Holding the shank in the regular spring chuck and stopping the machine for every one as the cap had to be taken off and put on for each piece, we were able to get 500 in ten hours. This brought the price up rather high.

We decided to let some outside firm make up about 50,000 to help us out and we were charged 56c. per hundred which seemed a lot of money for so small a piece. We got permission to tool up an automatic to make the part in one operation providing the saving in cost of manufacturing would offset the expenditures on special tools. We ordered a Brown & Sharpe high-speed drilling attachment with two drill holders, and had the bronze bushings that fit in the turret holes bored 0.028 out of center. We then made two hollow mills ⅜ inch diameter to fit the holders, the rougher leaving 1/32 inch for the finishing mill. The latter was adjusted to size by the regular collar. We used mills as they are more convenient for eccentric work and had to revolve in the drilling attachment. A set of cams were then laid out as follows:

Feed stock to stop and reverse spindle clutch, with belt off to stop spindle. Revolve turret and rough turn eccentric end with mill revolving and set 0.028 off center of spindle. Revolve turret and finish the eccentric end with hollow mill. Revolve turret and turn up to head with regular box tool (spindle running). Revolve turret and cut off, using screw slotter to slot head.

A strap was used around the pulley as a brake to insure its stopping. We were able to get out 2000 in ten hours, giving plenty of time for the mills to cut as the drilling attachment makes less than half the revolutions that the spindle makes while running. This was allowed on the cam lobes. Being successful we have to show where the price of tools comes from.

With the first method, performing the first operation in the automatic, and the second on the hand screw machine, the cost for 50,000 pieces, including overhead expenses and material was $351.66. The 50,000 made by the outside firm cost us at 56 cents per hundred as stated, $280. Under the new method the cost including overhead and material charges, plus $40 for the tools, was $100 for 50,000 parts. So the saving with the new method over the old one was $251.66 and the saving as compared with the cost of the parts when finished outside was $180.

WM. M. MCKENZIE.

New Rochelle, N. Y.

Piercing, Cutting-off and Forming Die for Small Steel Angles

The sketches illustrate the punch and die used for making the angle shown in Fig. 1. These angles are made of 1/16x ½-inch soft, cold-rolled steel and are pierced, cut off and formed at one operation. It will be noticed that the die is of very simple construction, yet it has proved very efficient.

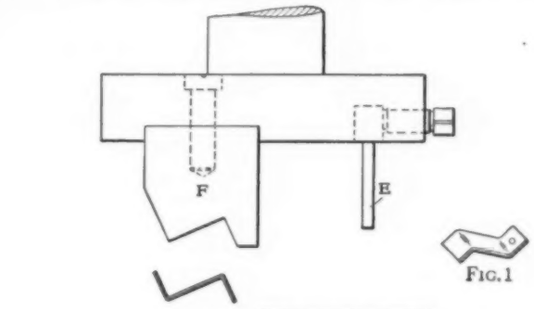


FIG. 1

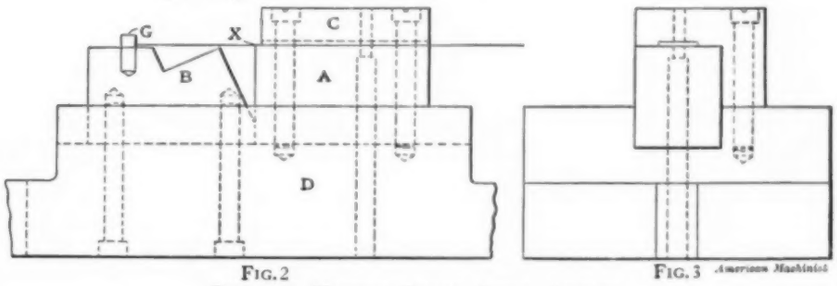


FIG. 2 FIG. 3

DIES FOR MAKING SMALL STEEL ANGLES

In Fig. 2 is shown a front view of the punch and die, with the strip in position to be punched. *A* is the piercing and cut-off portion of the die, *B* the forming part, *C* the inclosed stripper, and *D* the gray-iron die shoe. *E* is the piercing punch and *F* the forming punch. In Fig. 3 an end view of the die is given. The operation is as follows: The strip is placed in position on die *A* through the stripper *C*, so that a small portion will stick through at the cutting end of the die at *X*. The punch, in descending, pierces the strip, also trims the end square. Now push the strip through to the stop *G* and repeat the operation, thereby getting a finished angle at every stroke of the press. These dies are very rapid and are giving excellent service.

Urbana, Ohio. W. F. HOFFMAN.

Discussion of Previous Question

Why Have Ball Bearings Been a Failure?

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers.

The above question, raised by your contributor, E. J. Beale, at page 541, of the current volume, is based upon an altogether gratuitous assumption, and it would have been better if another question had been settled first, viz: "*Have* Ball Bearings Been a Failure?"

To this an emphatic answer in the negative must be given when the judgment is formed from an intelligent and comprehensive view of the position which these bearings occupy today and not from one or two isolated cases in which the accumulated knowledge and experience of years are entirely ignored. The case described upon page 418 of the same volume, where ordinary or gray cast iron was used for the races of a bearing carrying a heavy but apparently uncomputed load, is an example of this.

There are, of course, certain conditions and limitations which must be observed in the application of ball bearings, just as there are conditions in regard to the use of bearings of any other kind, without exception, but given the recognition of those conditions, success must as inevitably attend the use of the one as the other.

As to whether the advantages gained are commensurate with the expense involved is an entirely different proposition, and one that is of considerable importance though often overlooked, so that it may not be without interest to briefly examine the question from this point of view.

According to experiments conducted by Beauchamp Towers, under the auspices of the Institute of Mechanical Engineers, and published in the proceedings of that society for the years 1883-4, the frictional resistance of a steel journal running in a gun-metal bush, with oil-bath lubrication, was found to be, within the pressures and velocities observed, practically independent of the load and directly proportionate to the square root of the velocity. The coëfficient, therefore, varies inversely as the load, and with the best combination of the varying factors, viz: load, speed and lubricant, the exceedingly low value of 0.0008 was obtained.

Now, Professor Stribeck, in the report of his classical experiments, carried out at Neubabelsberg, Germany, about thirteen years ago, states that the coëfficient of friction for ball-journal bearings, within loads varying from the greatest permissible to half that amount, varied from 0.0013 to 0.0017, and gives as an average, 0.0015; this being, within very wide limits, independent of the velocity.

Other investigations conducted by Professor Goodman, of Yorkshire College, have shown that the starting effort required for ball bearings is very much less than that required for plain bearings under precisely similar conditions, the ratio arrived at being 7.5 to 100.

A comparison of these figures clearly shows that under certain conditions there is very little to be gained as regards the reduction of running friction by the substitution of ball for bronze, or other first-class bearings.

The conditions most favorable to the latter type of bearing may be enumerated as follows:

1. A properly fitted journal and bush.
2. Correct proportion of bearing surface to load, so that the most favorable pressure per square inch is obtained.
3. Perfect lubrication, such as is secured by an oil bath or by forced lubrication.
4. Low surface velocity, and
5. Continuous rotation in one direction.

It is, of course, true that all these conditions will but seldom prevail in actual practice, and a higher coëfficient than that given must generally be allowed. This, however, is equally true, though in a modified degree, in regard to the conditions necessary to a low coëfficient for ball bearings. The special advantages possessed by the latter become increasingly apparent when either the fourth or fifth conditions given above (or both) are impossible of attainment, the other factors being simply questions of design and workmanship. In other words, when a shaft is running at high speed and the motion is intermittent or variable, a very considerable advantage may be expected from the use of ball bearings. These conditions are found in a marked degree in automobile practice, and the general use of antifriction bearings upon these vehicles substantiates the statements herein advanced.

With regard to thrust collars, still greater advantages are obtained by the use of ball bearings, the respective coefficients for running friction being, as determined by the first two investigators mentioned, for plain collars, when thoroughly lubricated, 0.036 (as a mean of many experiments), and for ball thrusts, 0.001, but as the difficulties of efficient lubrication are much greater with thrust than with journal bearings, this does not adequately represent the great difference between the two types of thrust bearing under comparison.

It is somewhat difficult to understand exactly what your contributor intends to convey when he says: "It was not until Professor Stribeck . . . began his investigations . . and published the results, that a new era in the manufacture of ball bearings began," and again: "With the automobile came Professor Stribeck's researches and the ball bearing of today, the annular bearing and the ball-seated thrust bearing."

That these researches placed the design of ball bearings upon a scientific basis, and conclusively proved the superiority of that type of bearing in which the races are normal to the direction of the load, is freely admitted, but that this type, together with the spherical or ball-seated thrust bearing, was quite well known before the time of his experiments, is borne witness to by the Patent Office records, both of this country and the States, while the files of the early manufacturers themselves would reveal many drawings embodying the features mentioned. Not only this, but experiments carried out by the manufacturers (at least before Professor Stribeck's investigations were published in this country) showed that the load-carrying capacity of a ball bearing depends:

1. Directly upon the number of balls employed.
2. The square of the diameter of the ball.
3. The square root of the velocity, and
4. The shape of the groove or ball track.

Tables of safe working loads were published, which embodied the results thus obtained.

Other results arrived at by Professor Stribeck, and still laid down as essential by those who have not followed the rapid advances made by steel manufacturers and users, need to be revised, and it is certainly rather out of date to say that "the material of the balls and races must be of uniform hardness throughout, *not case-hardened.*" This is possibly true in regard to the balls, though mild steel, case-hardened balls are not an

improbability in the near future, considering the present status of the process of carbonizing and hardening, but it is certainly not true concerning the races.

The fracture of a mild steel ring, properly case-hardened, reveals an exceedingly hard outer surface, of a depth depending upon the length of time it has been carbonized; which changes almost imperceptibly into a soft core or center, the whole resulting in a ring eminently suited to withstand the straining actions to which ball bearings are subjected.

Of course, ordinary machinery steel will not give these results; it must be a steel especially prepared by the makers for case-hardening, but several such brands are now obtainable upon the open market.

Coventry, Eng. HAROLD SIBBERING.

Prevention of Scale in Hardening

Under the heading of "Prevention of Scale in Hardening," Charles A. Haeusser, on page 864, Part I, Volume 33, says: "There are many new methods of hardening, where the possibility of scale is done away with entirely. One of these is the electric oil heating bath, etc." This particular part of his article is, to say the least, somewhat misleading.

An oil heating bath is used for tempering tools, dies, etc., or anything that must be tempered after hardening. Whether the bath is heated by electricity, gas, crude oil, or even the open blacksmith forge, is all the same. It is a simple, sure and very rapid method of tempering, when you consider the old way of polishing and drawing to color.

To temper by the oil bath is to immerse the tools in the oil and then raise the oil to the proper temperature, just as you would polish a tool and apply heat by a hot plate or collar until you got the required color. More uniform results can be obtained with the oil bath, however, providing you agitate the oil occasionally.

With the oil bath, the thick part of a tool reaches the same temperature as the thin part. In other words, the tool has the same heat all over, at the same time, and the same rate of speed, whether it is thick or thin, heavy or light. The oil-tempering furnace is therefore the most efficient and reliable method of tempering tools, but not hardening them.

Mr. Haeusser then says: "The maximum temperature that it is possible to obtain is about 600 degrees Fahrenheit." (Can he harden a piece of carbon steel at that temperature?)

The maximum temperature is only limited by the flashing point of oil used. There are oils that flash at 500 degrees Fahrenheit as well as a good deal less, and again there are oils that will not flash until the temperature gets considerably above 600 degrees Fahrenheit. thus there is practically no reliable limit to the temperature of an oil-tempering furnace or oil-heating bath.

We have pyrometers to gage the hardening heats with. Why not use the thermometer to temper with? It being up to the hardener to get results, he can obtain the necessary knowledge as to temperature in relation to colors, by the perusal of books and papers dealing with this subject. This, coupled with some careful experimenting and a watchfulness, enables him to soon become proficient and rely on his thermometer at all times, when he knows the carbon content of his steel.

Decatur, Ill. GEORGE T. COLES.

Results from Premium Plan

The article at page 1017 came to my notice just after I had been talking with the proprietor of a large machine shop here in New England about the premium system in his shop. He pronounced it a failure. The way he answered my questions, and the answers to practically the same questions as given by Mr. Lodge, form a contrast that is worth knowing about in the same way that it is worth while to know the difference between woodbine and poison ivy.

Mr. Lodge took as a basis for the premium system the average cost by the day for three years. Mr. Manufacturer hired a crackerjack man at a fancy price and took his best record as a basis.

Mr. Lodge was willing and anxious that his men should earn more; so was Mr. Manufacturer, but not so willing.

Mr. Lodge's men made $20,000 in a year. Mr. Manufacturer, with half the number of men, paid less than $1000 in premiums in the same time.

Mr. Manufacturer has one piece on which his base time is half an hour. It is work that is given to 20-cent men. Only once in a year has the base been equaled. Usually it runs from an hour to an hour and a half. Only a few men make any effort to earn a premium; they are practically ostracized by their fellows.

These men are no fools. One of them worked for me for a number of years, and I tried a little premium plan on him just to help me out a bit. He ran the only tool of its kind that I could afford to own, and I needed two. I gave him half what he could save over his previous average time for a year back. He doubled his output, which increased his pay 50 per cent. and saved me a couple of thousand dollars for a new machine. He says that the reason why he earned a premium with me and not with Mr. Manufacturer is because he could do it with me and he could not with the other fellow. He says that before he can earn a premium now he has to work so fast that he is utterly worn out at night. He does not propose to kill himself to earn the little extra that he might.

This shop has extra good facilities for doing work and its costs are low, but it does seem as if they could make money by putting their premium on a "live and let live" basis. If a man is drawing day pay of $3, he will not rush a particle to make 10 cents a day extra. If he can see a chance to make $1.50 per day extra, he will work his head off to do it. It is necessary to offer perceptible rewards for quick work in order to get it, and that is also a business proposition.

TWO OTHER MANUFACTURERS

By the way, speaking of Mr. Manufacturer reminds me of two other men of my acquaintance, both grown scandalously rich through manufacturing, both successful men, but both losing their grip. Man number one has ruled his factory for years through fear. His foremen will sneak around outside the shop to get from one department to another to avoid meeting the old man, for he is always loaded to the muzzle with fault finding. No one works for him today except those who cannot get other jobs or who are scared into thinking they cannot. No wonder he is losing his grip.

The other, number two, is a man who has always run his shop on the human sympathy line. He called every man by his first name and inquired after his wife and children by name. If anyone was sick, he inquired about him through his shop neighbors. In a word, he treated his help like a great family. As time went on, he began to grow, as stated above, scandalously rich. In an evil day he bought a silk hat and a frock coat. He was reported to have been seen one evening in a dress suit! This began his downfall in the hearts of his men. He joined a golf club and that finished him. They talked of him in the past tense. What a fine man he *had been*. How he *used* to take care of his old worn-out help. How he *used* to inquire after Maggie when she had the rheumatism. They dropped all idea that he was one of them and they repulsed his advances when he tried to be as he was. Finally he had to give it all up and hire a superintendent that wore baggy trousers, to handle his job.

Moral: It is suicide to play the races, but it is safer than bulldozing your help or wearing a silk hat.

Springfield, Mass. ENTROPY.

One really extraordinary feature about ductile metals is, according to *Engineering*, their occasional fracture with no apparent ductility whatever. Steel plates have on occasion been riveted into place in the morning and have split spontaneously in a diagonal direction at noon. Test-pieces cut from the immediate neighborhood of the fracture have, nevertheless, shown no particular abnormality under the ordinary tensile tests.

Distribution of Load in a Ball Bearing

By F. H. Poor *

A discussion of some frequent misinterpretations from the ball-bearing tests and analyses made by Professor Stribeck.

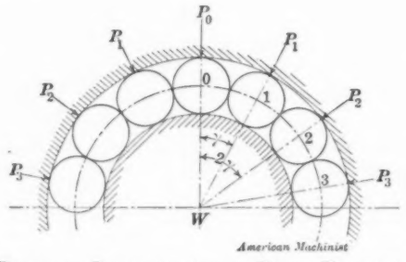
*Manager, the S. K. F. Ball Bearing Company, New York City.

Among those who have interested themselves in the subject of ball bearings there are probably but a few who are not acquainted with the extensive researches carried out some years ago by Professor Stribeck, of the Central Laboratory for Scientific Technical Investigation at Neubabelsberg, Germany. Quotations from the reports of his investigations appear in trade catalogs on ball bearings; text books, in which it may be added any treatment of the subject of ball bearings is of comparatively recent consideration, have also adopted Professor Stribeck's formulas; and the work of this celebrated German engineer has been universally recognized as the most comprehensive and authoritative treatise on this subject which has ever been published.

It appears to me that Professor Stribeck's reports have in some instances suffered misinterpretation, possibly by reason of an improper analysis of his formulas, and certain factors which enter into their determination. I refer to the statement which is sometimes made that the total load is carried on one-fifth of the total number of balls.

On reference to Professor Stribeck's report on "Ball Bearings for Various Loads" translated by Henry Hess (See Volume 29 Transactions American Society of Mechanical Engineers) it is shown that the permissible load on a single ball is equal to a constant times the square of the ball diameter; that is,

(a) $P_m = K d^2$ (Stribeck's equation No. 4)



PARTIAL DIAGRAM OF A BALL BEARING

and that the largest load on one ball in a single-row bearing may be considered equal to five times the total load on the bearing divided by the number of balls; that is,

(b) $P_o = \frac{5P}{z}$ (Stribeck's equation No. 11)

If we use $P_o = P_m$, combine these two equations (a) and (b), and solve for P we obtain,

(c) $$P = \frac{K d^2 z}{5}$$

which gives us the maximum permissible load on a single-row ball bearing.

P = Total load on the bearing.
P_o = Largest load on one ball.
P_m = Maximum permissible load on one ball.
K = Constant depending upon the qualities of the materials and form of races.
d = Diameter of balls, using ⅛ inch as the unit.
z = Number of balls.

Professor Stribeck's equation No. 11 was derived by the use of the diagram shown herewith, in which the total load on the bearing P has been considered as the summation of the distributed loads on the several balls above the center line of the bearing, P_o, P_1, P_2, etc. All the balls above the center line carry a certain proportion of the total load, and the amount of load which they are each called upon to sustain is dependent upon their position with respect to the vertical line WO drawn through the center of the bearing.

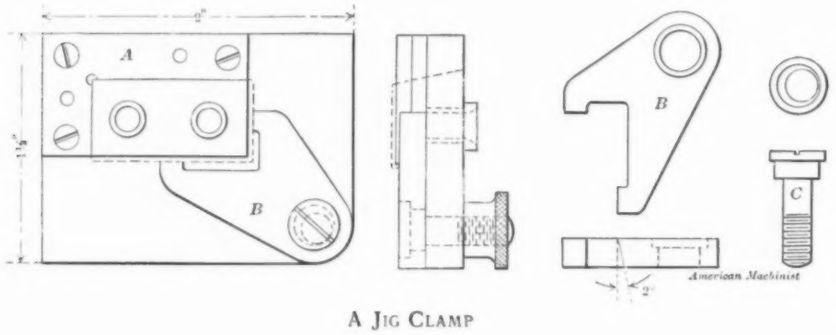
In using formula $P = \frac{K d^2 z}{5}$ I believe that many have interpreted the factor $\frac{z}{5}$ to mean that one-fifth of the total number of balls carry the load.

The above diagram taken from Mr. Hess' translation of Professor Stribeck's report, together with this short analysis of his formulas should suffice to show that the above interpretation is erroneous.

Automatically Adjusting Jig Clamp

By George E. Gay

The drill jig described herein is shown merely to illustrate the work clamp, which is constructed so that one movement exerts a clamping pressure in two directions, the clamp automatically adjusting itself to any variations in the size of the work drilled.



A JIG CLAMP

This jig drills two holes in hard brass pieces 1x1½x3/32 inch, one of which is indicated by the dotted lines, located against the two edges of hardened stop A, and clamped by the two-pronged clamp B, operated by an eccentric pin C and nurled nut. This nut is screwed and pinned to the eccentric pin so as to allow the clamp to be a free working fit. Both the edges of location strip A and the contact faces of clamp B are undercut two degrees to pull the work down flat on its face.

The construction described allows the clamp to float during the clamping movement, and adjust itself with approximately equal pressure on both edges of the work; the pins shown being provided to maintain the clamp in a convenient position to facilitate the insertion and removal of the work. It will be seen that only a half turn of the nurled nut is required to clamp or release it.

The principal manufactures of iron and steel imported into the United States in the fiscal year 1910, just closed, are: Machinery, about $9,000,000; pig iron, $6,500,000; tin plates, $4,500,000; ingots, blooms, etc., $3,500,000; cutlery, $1,750,000; wire and articles made from wire, $1,500,000; scrap iron, $1,500,000; and bar iron, nearly $1,500,000, while no other single class of iron and steel shows for the year a total of $1,000,000 or upward.

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American Machinist

Editorial

What the American Machinist Stands For

Judging from letters which we occasionally receive from our friends, some of them do not seem to clearly understand the functions of a technical paper.

One of the stumbling blocks seems to be the idea that the paper indorses, or "stands for," everything that appears in its columns. It is not easy to see how such an idea gains ground because there are few subjects discussed or ideas advocated on which we do not print such widely differing views that it would be impossible for us to stand for them all.

It is the business of a live, technical paper to give its readers the experiences and practice of the best men in their line of work; to give them as much information as possible as to what is being done in various parts of the country.

To this end we travel thousands of miles and pay large sums of money for articles showing what is being done and the methods used. It is needless to say that some of these are not all that might be desired, or that they are not all approved by the editors.

Because one man writes of his failures to secure good results with high-speed steel, a few seem to think that the AMERICAN MACHINIST has taken a "stand" against that extremely useful product. Or if some one should criticize any of the numerous shop systems, we are accused of being opposed to it or to all systems.

If the columns of the AMERICAN MACHINIST were not open to both sides of any shop problem, it could rightfully be called narrow and one sided. And whatever its faults, it does not intend to be guilty of that.

Only what appears on the editorial page can be called the "stand" or attitude of the paper. And whether the ideas advanced in this way meet your views or not, we trust that you will try to believe that they represent what the editors feel to be for the best interests of the industry as a whole.

We can perhaps, view the whole field with a little better perspective than those who are actively engaged in any particular part of it, and we always try to bear in mind the future welfare as well as the present. But we are still very human and a long way removed from infallibility, so that we shall always welcome honest criticism.

And, whatever happens, it is our earnest desire to make the AMERICAN MACHINIST stand for all that will make for the broadening and betterment of the whole industry. This includes the employer and the employee as well as all the machinery and methods involved, not only for the present, but for the future.

Metal in Shop Sweepings

One of the refinements in machine-shop management, which is being looked into in some quarters, is the determination of the amount of metals wasted in the sweepings of the shop. This does not mean the waste due to chips or pieces of metal which are large enough to be seen and saved by having the sweepings screened, but refers to the small particles which go through the screen and are swept up with the dirt.

In one shop at least, a number of experiments have been made by the shop chemists to determine the amount of metal in such sweepings and to find the best way of recovering it. So far as the experiments have gone, it is not certain that the amount of metal recovered will pay for the cost of recovering it, even though there is more metal recovered from a ton of sweepings than might be imagined after seeing them screened in this particular plant. Whether it proves a paying investment or not in this particular shop it is a point well worth considering. There are many shops where it would be pretty sure to pay, although the shop in question takes extraordinary care to prevent waste in this direction. It will seem strange to many that this should be a railroad shop, as in the past they have never been noted for the smaller economies which sometimes prevail in a manufacturing plant.

UNIFORMITY IN NAMES OF TOOLS

There has always been more or less confusion owing to the indiscriminate and interchangeable use of the terms "arbor" and "mandrel" without any apparent reasoning for either use. There seems to be a growing tendency, however, to use the word "arbor" as designating the device on which milling cutters or the cutting tool is mounted, while the name "mandrel" is being more and more applied for holding and driving the work to be operated on. This seems to give as good a distinction as can be had, and uniformity is much to be desired.

A Works Manager's View of the Apprentice Question

All who are interested in the problem of securing skilled mechanics should read the address by B. M. W. Hanson before the Manufacturers' Association, of Hartford, Conn., which appears in another column. It is Mr. Hanson's experience that regularly trained apprentices make much more skillful mechanics than handy men, even in special manufacturing lines, and the fact that he has risen to his present position from a mechanic at the bench, indicates clearly that he knows the problems involved from actual contact with them.

Assuming that apprenticeship is desirable, very few will deny the advantage or the necessity of his suggestions in regard to making the shop as attractive as possible, and to the question of remuneration, both during the apprenticeship and after the boy has graduated or is "out of his time," according to the old way of stating it. We are glad to note that many manufacturers are looking at this question from the same point of view, and we believe there is no question that these manufacturers are having little difficulty in securing the necessary boys for their work.

High Cost of Living and Depreciation

A thousand dollars put on interest in our savings banks and the interest allowed to accumulate for 10 years will not buy today as much of the necessities of life as the original thousand dollars would have brought when deposited. That thousand dollars has depreciated. Another thousand dollars invested in any of the best makes of machine tools and the tools used with reasonable carefulness for 10 years past is still a thousand dollars. That thousand dollars has increased in value to the extent of the use of the machinery. In other words the careful investor can show by his books that he has made money, but as a matter of fact he has lost; at the same time the proprietor of a shop can show on his books a yearly depreciation of his machinery and yet look out into his shop and see that he has profited.

Everybody was impressed with the scarcity of profits 10 years ago. For years back of that when men were dissatisfied with their profits they looked to their costs of manufacture and put forth their energies to reduce them. Then prices began to rise. The jobbers, manufacturers, labor and probably sooner or later, investors, all asked for more. The builder of machine tools has advanced his prices and the jobber has advanced his. The price of labor has advanced, but the cost of hired money has not advanced perceptibly. If all these elements had advanced together there would have been no difference to anyone except that he would handle more money. As it is we have the curious anomaly of a highly prosperous country full of people who have had their pay raised but who are poorer than they ever were before. And depreciation measured in dollars and cents is overbalanced in many cases by appreciation measured in the same terms.

Yet depreciation must have taken place; that is, the machinery that has been used for 10 years is not the same as when it was new.

Standards for Automobile Materials

The Society of Automobile Engineers, which meets in convention at Detroit, Mich., on July 28, has an excellent opportunity to perform a lasting service to the automobile industry and one which will benefit the purchasers of cars.

One of the important subjects for discussion is the standardization of specifications for motor-car materials, with a view of securing a uniformity of sizes and quality, which will enable manufacturers to specialize and supply a better quality more promptly and at a lower price.

As an instance of the difficulties arising from the absence of a standard, we are informed that automobile manufacturers have specified as many as 1600 tube sizes. The standard tubes listed cover about 300 sizes, which would seem to be enough for any designer to choose from. A standard for tube sizes will be proposed at the meeting and it seems quite probable that it will be adopted.

Both G. E. Merryweather and H. E. Coffin deserve credit and support for the work they are doing in this direction and have our hearty wishes for their success.

New Publications

Report on Old Age Pensions, 1910. A report of the Commission appointed by the Commonwealth of Massachusetts to investigate systems of old age insurance and pensions. Wright & Potter Printing Company, Boston, Mass.

Those whose interest along sociological lines runs in the direction of pensions for incapacitated workmen, as well as those who may not have formulated any specific remedy, will be interested in this book. It is a neatly printed and bound volume of something over 400 pages, and in addition to interesting statistics in regard to the expenditure now necessary for the relief of those who are incapacitated by old age, it shows what is being done to relieve this situation.

It describes the old-age pension systems of Germany, England, Denmark, Belgium, France, Italy, New Zealand, New South Wales, Victoria, Australia, Canada and Austria, which are all matters of state control. It reviews pension legislation in the United States, gives the pension system of the American railroads and industrial corporations, of the Krupp Company, in Essen, Germany, the old-age benefits of the British Friendly Society, of fraternal organizations, and trade unions. It also takes up industrial insurance, Massachusetts savings-bank insurance, and gives an analysis of existing and proposed schemes. It shows the costs of various pension schemes as applied in Massachusetts, takes up the municipal pension systems of American and foreign cities, and, in fact, seems to be one of the most complete works along this line which we have seen. It should be extremely valuable to those who are contemplating or at least looking into methods of this kind, and there seems to be no reason why it should not become a valuable reference book on this subject.

Personals*

Otto W. Schaum, president of the Fay Machine Tool Company, Philadelphia, Penn., sailed on July 7 for a trip through Europe.

William E. Smith, formerly connected with the American Locomotive Company, has joined the drafting division of the Browning Engineering Company, Cleveland, O.

V. M. Palmer, who has ben chief engineer of the Selden Motor Vehicle Company, Rochester, N. Y., has accepted a similar position with the Sheldon Axle Company, Wilkes Barre, Penn.

C. M. Garland, until recently instructor in mechanical engineering at the University of Illinois, has become connected with the Camden Iron Works, Camden, N. J., acting as mechanical engineer.

Robert L. Streeter, instructor of machine design at the Buffalo Technical High School, has accepted the chair of assistant professor of mechanical engineering at the Rensselaer Polytechnic Institute, Troy, N. Y.

J. R. McColl, until recently mechanical engineer in the employ of the American Blower Company, Detroit, Mich., has become member of the firm of Ammerman, McColl & Anderson, prosecuting a consulting practice, with headquarters in Detroit.

Herbert L. Smith has concluded his employment as engineer in charge of the electric welding department, Clinton Wire Cloth Company and has entered the service of the Universal Electric Welding Company, of Long Island City, as mechanical engineer at their New England branch office in Westerly, R. I.

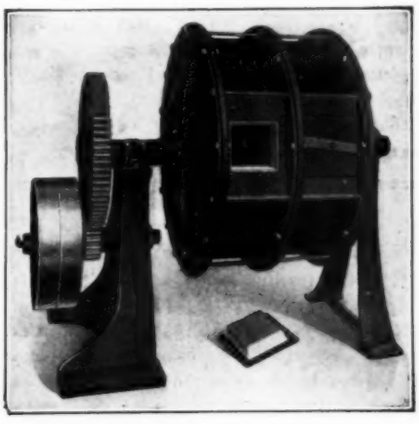
*Items for this column are solicited.

New Tools and Shop Appliances

The Abbott Tumbling Barrel

The barrel shown in the halftone is built especially for the purpose of burnishing small metal goods with the use of steel balls. The barrel is built in two compartments but its construction is such that it can be furnished in one, two, three or four compartments to suit requirements. Each compartment of this size barrel is 30 inches diameter and 8 inches wide (inside measurements). This size barrel is designed more especially for those manufacturers who have large quantities of such articles to burnish as saddlery, hardware, buckles, hose supporters, cabinet hardware, etc. It is the intention, however, to build them in two smaller sizes, namely: about 24x7 feet and 18x5 inches. The smallest size will be more especially for manufacturing jewelers' use.

Our idea in making these compartments narrow and of large diameter is



THE ABBOTT TUMBLING BARREL

that when the barrel is loaded with work and balls there is a considerable depth which makes a pressure on everything that is at the bottom of the load, thereby increasing the friction and also giving a more rapid burnishing effect on account of there being a long sliding space for the balls to slide over and under, in and out of the work, at the same time there is no impact which takes place in some forms of barrels. Also the barrel being irregular in shape the articles are kept agitated at all times. While the sliding effect is desired, there must be no impact, as impact will dent the work rather than burnish it. There is no tendency of this sort in this barrel. In short, the object of this barrel is to secure a long slide free of impact. It is built by the Abbott Ball Company, Hartford, Conn.

ANY and all new or improved machines, tools, or shop appliances of interest to men responsible for results in machinery-making plants will be briefly illustrated and described here—the machine shop news.

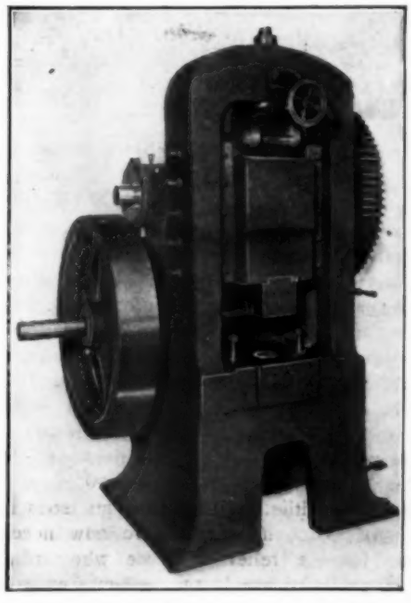
A more full and detailed description will be given—when it is real news—if it can appear here first—before it is sent to other papers. All descriptions appear in ALL four editions of the paper—Weekly, Monthly, Weekly English and Weekly German.

A Toggle Embossing Press

The halftones show front and rear views of a toggle embossing press weighing 13,800 pounds. The cast-steel frame weighs 7000 pounds and has tensile strength of 80,000 lb. per square inch. The crankshaft is of forged nickel steel and drives the main toggle in a horizontal direction. The main toggle is of forged steel, bronze bushed around the wrist pin. The main drive-in toggle weighs 600 pounds. The two vertical toggles are forged steel and the lower one seats in a phosphor-bronze thrust shoe which is in the cast-steel slide of the press. The supporting pin of the slide as well as the two toggles are of hardened and ground tool steel.

The driving shaft is fitted with a 1300-pound flywheel, 42 inches diameter, seven inches face. This is put in close to the frame and is supported by heavy outboard bearing, not shown. The opposite end of the driving shaft is equipped with the forged steel pinion driving into the cast-steel clutch driving gear. Both pinion and clutch gear have cut teeth, and the gear is fitted with an instantaneous roller friction clutch, allowing less than 1/32-inch travel of the flywheel after the clutch is engaged.

On this particular clutch the dog or latch for stopping is fitted with special counterweight for high speed and to relieve the strain of quick stop. The adjustment controlled by the hand wheel on the front of the press consists of a hardened and ground tool-steel wedge sliding between wedge collars. The machine has both hand lever and treadle tripping device and is set upon a hollow cast-iron base. The frame is made in one piece with a table thickness of solid cast steel, ten inches. The distance between the uprights at the bed of the press is 17½ inches. When there is a hole in the bed it is regularly made five inches diameter, but could be made as large as 15 inches diameter, round or



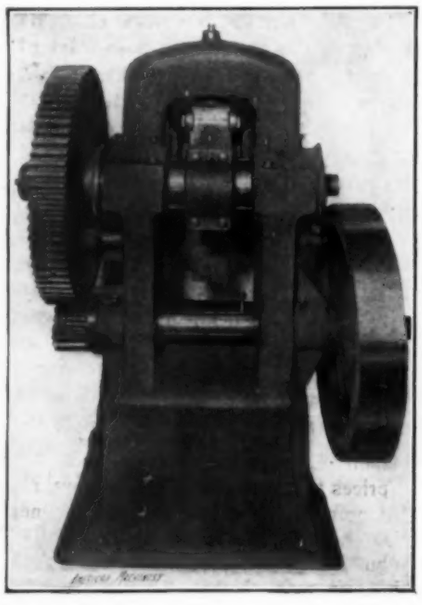


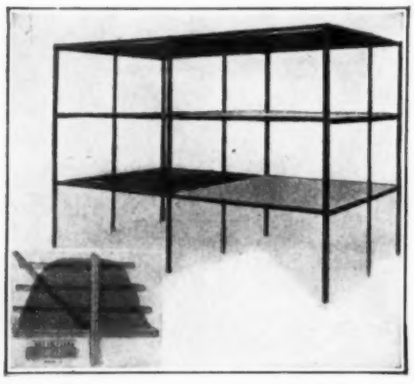
FIG. 1. A TOGGLE EMBOSSING PRESS FIG. 2

square. The gibs are extra long, which gives the slide a bearing during its entire length.

The press is made both plain and geared; net weight of plain press being 12,500 pounds. The balance wheel on the plain press weighs 1800 pounds and is 50 inches diameter. The pressure developed by the back-geared press is 350 tons. This press is built by the Standard Machinery Company, Providence, R. I.

Pattern Storage Rack

The illustration herewith shows an improved type of pattern-storage rack, more especially designed for wooden frames



PATTERN STORAGE RACK

recently brought out by the Manufacturing Equipment and Engineering Company, Boston, Mass.

This rack is well adapted for preserving and storing wooden patterns. The shelves are made of No. 16 gage 2x2 galvanized iron wire-cloth.

The use of wire-cloth tends to eliminate warping of the patterns as both sides of the pattern are equally exposed to the air. This type of shelf also allows the dirt to drop through, and finally get to the floor and makes for more light than the solid type. They are rigidly constructed and are complete units, and can be removed, without any change in the main frame. The main frame is carried on angle iron posts, so constructted that any section can be removed from the main rack, or any shelf can be adjusted in the frame, or new shelves added at any time.

This type of rack readily stands on its own supports, and is not attached to the building in any way. Although they are more especially designed for wooden patterns, they can be readily adapted to metal patterns by using heavier gages of wire-cloth and are being installed in many of the leading manufacturing plants throughout the country.

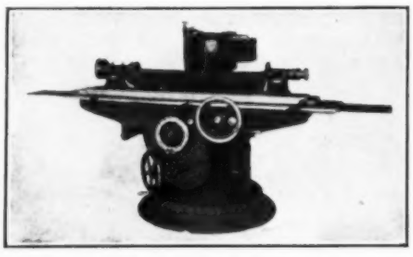
Substantial Oil Can

The Ansonia Novelty Company, of Ansonia, Conn., is making a new oil can of sheet metal in which the bottom is put in without solder, brazing or cement of any kind. It is made of cold-rolled steel, the bottom being secured by rolling over the edges in such a way that it becomes practically a one-piece can. It is made either polished or copper-plated and is very strong for its weight.

The Thompson Universal Grinding Machine

The engraving illustrates the Thompson universal grinding machine as manufactured by the Thompson Grinder Company, of Springfield, O.

The engraving shows the machine set up for cylindrical grinding, together with the various attachments which are regularly furnished with the machine. For surface grinding, all that is necessary is to swing the grinding table around on the right-hand side of the grinding

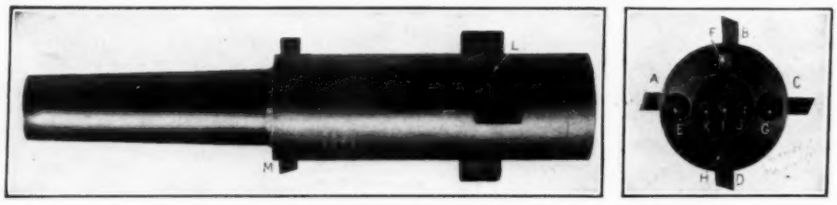


THOMPSON UNIVERSAL GRINDING MACHINE

head. For knife grinding the grinding table should be swung around on the left-hand side of the grinding head. The internal attachment is easily placed on the machine, being mounted on the grinding head, and receiving its drive from a pulley placed on the main grinding spindle. For faceplate and die grinding the grinding table is left in the same position as for cylindrical grinding, a large faceplate being mounted on the headstock. Thus the machine is converted into at least five distinct kinds of grinders. Aside from these distinct kinds of grinding, the sharpening of hobs, spiral cutters, end mills, etc., can be taken care of.

An Expanding Boring Bar

The halftone shows a bar designed for boring car wheels. It has four cutters, each of which is independently adjustable so as to divide up the metal to be removed. A water attachment is provided so that a small stream of water is directed to the cutting tools. Each



AN EXPANDING BORING BAR

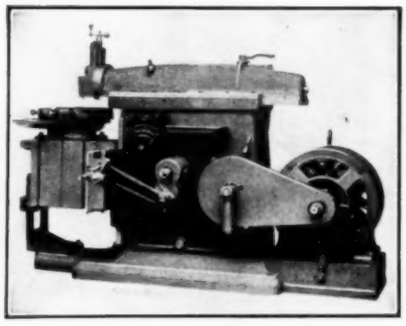
size bar has a range of adjustment of two inches, so that one size bar will bore two sizes M. C. B. standard wheels.

The back or inner ends of the cutters *A*, *B*, *C*, and *D* are ground at an angle and abut upon wedges in the center of the bar. The set screw *L* binds all these wedges firmly in place. The wedges behind the cutters *B* and *D* are adjusted by the set screw *I* in the center of the bar and the cutters *A* and *C* are adjusted by the wedges behind the set screws *K* and *J* respectively. The cutter *M* is for chamfering the edge of the bore. With this tool from 70 to 80 steel wheels have been bored in ten hours.

This bar is made by the Buck Boring Bar Company, Huntington, West Va.

Chain Motor Drive

The illustration shows a 24-inch back-geared Queen City shaper, driven by a 5½-horsepower Westinghouse type SA motor with auxiliary commutating poles. The drive is by means of a silent chain which is thoroughly guarded both for lubrication and safety. The motor is of



CHAIN MOTOR DRIVE

the variable-speed type, having a range of from 450 to 1350 revolutions per minute. The motor speed is said to be practically constant for each position of the controller, regardless of its load.

Water Power and Pipe Line Estimates

By D. M. McLean

Some tables for estimating horsepower available from water under practical operating conditions, together with commercial weights per foot of steel tubing and steel plates.

The accompanying tables have been prepared for use in connection with preliminary work on water-power surveys, estimates of power available, cost of development, and the sale of water-power equipment, etc. They will be found useful whenever it is necessary to quickly make up safe figures in field or office, for prospective customers regarding probable amount of power available, size of pipe line, weight and cost of pipe, etc.

As a general rule, the published tables of horsepower of water under various heads are calculated on the basis of an efficiency of either 80 or 85 per cent. While the average available flow of a stream may be, for example, 20,000 cubic feet per minute, and the head, say 40 feet, and according to the usual table of 80-per cent efficiency, be capable of yielding 1210 horsepower, it is evident that it is not well to quote this figure to the prospective user, for while the turbines themselves may have an efficiency of 80 per cent. or over, several causes intervene to prevent the full flow of the stream reaching the wheels. These causes may be evaporation, leakage from dam and intakes, loss of head through change of direction on the way to the wheels, insufficient tailrace area, etc. Under the most favorable conditions the total available flow of the stream can hardly be utilized at better than 75 per cent. efficiency, and in some cases, particularly in the smaller plants where the installation will be performed by others than the makers of the turbine, and the engineer's specifications and drawings, if any, may not be followed in their entirety, it is generally best to base the preliminary figures on not over 70-per cent. efficiency.

Table 1 was prepared to suit average conditions, and has been found to check fairly well with results obtained after complete development of a given water power. The table is, of course, based on the constant 0.0014187 which is the horsepower of one cubic foot of water per minute under one-foot head at 75-per cent. efficiency.

Figures for quantities of water not given in the table may be readily obtained by combinations, as for example: 17,250 cubic feet per minute under 30-foot head. What horsepower?

10,000 cubic feet.	425.6 horsepower.
7,000 cubic feet.	297.82 horsepower.
200 cubic feet.	8.51 horsepower.
50 cubic feet.	2.13 horsepower.
17,250 cubic feet.	734.06 horsepower.

Figures for intermediate heads may be found by interpolation, or we may use the formula: 0.0014187 (or 0.00142) × head × cubic feet of water per minute = horsepower at 75-per cent. efficiency.

Conversely, if the power be named in advance, we may find the quantity of water necessary to develop it at 75-per cent. efficiency. For example, it is desired to develop 700 horsepower under 20-foot head; how much water will be required?

$$\frac{700}{0.0014187 \times 20} = 24{,}671 \textit{ cu. ft. per minute.}$$

If in the first example it is desired to reduce the figures to 70-per cent. efficiency, take off 6⅔ per cent. In the second example, add 7.14 per cent., or substitute the constant 0.001324 for the constant 0.0014187.

In Table 2 is given the carrying capacity of straight wooden or steel tubes of various diameters, at various rates of flow, from one foot to six feet per second. Rates of flow for intermediate speeds may be found by combination or interpolation. The table covers the usual range of sizes and velocities. Velocities over six feet per second are used under special conditions, but may be dealt with by making suitable combinations from the table.

Cu. Ft. per Min.	Head in Feet.											
	1	5	10	20	30	40	50	60	70	80	90	100
1,000	1.42	7.09	14.19	28.37	42.56	56.75	70.94	85.12	99.31	113.49	127.69	141.87
2,000	2.84	14.19	28.37	56.75	85.12	113.50	141.88	170.24	198.62	227.00	255.38	283.74
3,000	4.26	21.28	42.56	85.13	127.68	170.25	212.82	255.36	297.93	340.50	383.07	425.61
4,000	5.67	28.38	56.75	113.50	170.24	227.00	283.76	340.48	397.24	454.00	510.76	567.48
5,000	7.09	35.47	70.94	141.87	212.80	283.75	354.70	425.60	496.55	567.50	638.45	709.35
6,000	8.51	42.56	85.12	170.24	255.36	340.50	425.64	510.72	595.86	681.00	766.14	851.22
7,000	9.93	49.66	99.31	198.62	297.92	397.25	496.58	595.84	695.17	794.50	893.83	993.09
8,000	11.35	56.75	113.50	226.99	340.48	454.00	567.52	680.96	794.48	908.40	1,021.52	1,134.96
9,000	12.77	63.85	127.68	255.37	383.04	510.75	638.46	766.08	893.79	1,021.50	1,149.21	1,276.83
10,000	14.19	70.94	141.87	283.70	425.60	567.50	709.40	851.20	993.10	1,134.90	1,276.80	1,418.70

TABLE 1. BRAKE HORSEPOWER AVAILABLE FROM WATER UNDER VARIOUS HEADS AT 75 PER CENT. EFFICIENCY.

The column showing the cubic feet of water per minute flowing at a lineal speed of one foot per second may be used as follows, to discover the velocity required to deliver a given quantity of water through a tube or opening of a given diameter. For example, with a speed of one foot per second, a 54-inch gate valve will deliver 954 cubic feet of water per minute. If it is to deliver 10,800 cubic feet per minute, what must be the rate of flow?

Diameter, Inches.	Speed in Feet per Second.			
	1	4	5	6
20	131	523	654	785
24	188	754	942	1,130
30	294	1,178	1,473	1,768
36	424	1,697	2,121	2,545
40	524	2,095	2,619	3,143
42	578	2,313	2,886	3,459
48	774	3,097	3,871	4,645
54	954	3,816	4,770	5,724
60	1,178	4,714	5,892	7,070
66	1,423	5,692	7,128	8,554
72	1,696	6,785	8,481	10,177
78	1,991	7,963	9,954	11,945
84	2,309	9,235	11,544	13,853
90	2,651	10,603	13,254	15,905
96	3,016	12,065	15,081	18,097
102	3,405	13,620	17,025	20,430
108	3,817	15,269	19,086	22,903
114	4,253	17,011	21,264	25,517
120	4,713	18,850	23,562	28,274
126	5,176	20,702	25,877	31,052
132	5,702	22,807	28,509	34,211
138	6,232	24,929	31,161	37,392
144	6,786	27,144	33,930	40,716

TABLE 2. CUBIC FEET OF WATER PER MINUTE DELIVERED BY TUBES OF VARIOUS SIZES AT VARIOUS VELOCITIES.

$$\frac{10{,}800}{954} = 11.3 \textit{ feet per second.}$$

Gate valves used in hydraulic plants are expensive items, and while it is usual to keep the sizes down as much as possible, this table readily shows when the limit of speed of flow has been reached.

It should be noted that velocities calculated from the head, slope, etc., by the usual formulas, are often reduced in practice by friction losses not at first considered, so that the quantities given in the table might be subject to some reduction, particularly in long penstocks and at the higher velocities of flow. Therefore, when a certain quantity of water is to be provided for, it is generally best to choose a diameter of pipe and a rate of flow which will deliver a little over the quantity desired, rather than under.

In preliminary work, it is seldom well to figure on a velocity exceeding 4 feet per second in steel pipes, although on further study in the designing room it may be found practicable to increase the speed of flow. The question of allowable velocity calls for the exercise of engineering judgment, and the rate of flow finally adopted will depend upon several factors. Generally speaking, a high head will permit of a greater pipe-

line velocity than a lower, on account of the smaller percentage of head lost in friction, and speeds of 8 to 13 feet per second are found in some installations. Economic considerations have a bearing on the diameter of the pipe employed, and in the case of long penstocks, the diameter will be reduced and the rate of flow increased as far as may be practicable.

Table 3 gives the weights per running foot of straight steel pipe of various diameters and thicknesses of metal for various heads. The figures are based upon straight pipe with lap joints, having single-riveted girth seams and double-riveted longitudinal seams. The thicknesses of plate are taken on the basis of a factor of safety of not less than 8, under the static head for which the tubes are designed in the larger diameters, the factor gradually increasing to the smallest diameter and thinnest plate, so as to provide for overpressure, and in the lighter weights of material, a margin also for corrosion of oxidation.

Diameter in Inches.	10 Feet to 30 Feet Head.		30 Feet to 60 Feet Head.		60 Feet to 90 Feet Head.		90 Feet to 120 Feet Head.	
	Plate Thickness, Inches.	Weight, Pounds.	Plate Thickness, Inches.	Weight, Pounds.	Plate Thickness, Inches.	Weight, Pounds.	Plate Thickness, Inches.	Weight, Pounds.
20	1/4	32	5/16	48	3/8	64	7/16	79
24	1/4	38	5/16	77	3/8	94	7/16	112
30	1/4	72	5/16	96	3/8	118	7/16	140
36	1/4	86	5/16	115	3/8	142	7/16	168
40	1/4	96	5/16	128	3/8	157	7/16	187
42	1/4	100	5/16	134	3/8	166	7/16	197
48	1/4	115	5/16	189	3/8	225	7/16	260
54	1/4	173	5/16	213	3/8	253	7/16	293
60	1/4	192	5/16	235	3/8	279	7/16	323
66	1/4	211	5/16	259	3/8	308	7/16	357
72	1/4	230	5/16	336	3/8	390	7/16	439
78	1/4	307	5/16	365	3/8	422	7/16	476
84	1/4	331	5/16	394	3/8	456	7/16	514
90	1/4	353	5/16	420	3/8	486	7/16	548
96	1/4	378	5/16	449	3/8	586	7/16	658
102	1/4	400	5/16	476	3/8	621	7/16	696
108	1/4	425	5/16	585	3/8	659	7/16	739
114	1/4	448	5/16	616	3/8	694	7/16	779
120	1/4	472	5/16	650	3/8	732	7/16	906
126	1/4	589	5/16	682	3/8	862	7/16	951
132	1/4	617	5/16	714	3/8	902	7/16	996
138	1/4	645	5/16	747	3/8	943	7/16	1041
144	1/4	672	5/16	779	3/8	984	7/16	1087

TABLE 3. COMMERCIAL WEIGHTS PER RUNNING FOOT OF STEEL TUBING 20 TO 144 INCHES DIAMETER.

FOR HEADS 10 FEET TO 120 FEET INCLUDES USUAL MANUFACTURING OVERWEIGHT.

The higher the velocity of flow, the greater the necessity for special provision for relief under excess of pressure due to water hammer from sudden changes of flow. Any of the devices employed for this purpose, whether overflow basin, standpipe, relief valve or bursting plate, represent increased first cost of installation as well as upkeep. Consequently, the various factors must be carefully balanced against each other, and like many other engineering undertakings, the finished hydraulic plant is often a combination of compromises.

The weights are based on the practice of leading manufacturers, and will be found somewhat in excess of the usual published tables and purchasers' specifications, the latter in some cases differing considerably from actual weights of finished pipe, owing to the fact that they have been calculated without the allowances which the manufacturer makes for overweight in plates, laps, etc.

Under higher heads than those given in Table 3, it is generally necessary to employ tubes made with buttstrap joints, either double or triple riveted, as the case may require. In such cases special estimates are usually made, based on the quantity of plate and rivets required to make 100 lineal feet of pipe. In estimates of this kind, I prefer to use the full allowance for overweight for rectangular plates when ordered to gage, as adopted by the American Steel Manufacturers' Association, and applying to plates from 50 to 75 inches wide. The bulk of penstock work is made up of plates ranging from 60 to 72 inches wide, for convenient handling in shop and field, as well as when two courses are riveted together in the shop and shipped standing on end, in which case the railway companies impose certain limits for hight above the rail.

Thickness Inches.	Theoretical Weight, Pounds.	Allowance for Overweight, Plates 50 to 75 Inches Wide.	Adjusted Weight, Pounds.
		Per Cent.	
3/16	7.65	10	8.42
1/4	10.207	10	11.23
5/16	12.75	8	13.78
3/8	15.31	7	16.38
7/16	17.86	6	18.93
1/2	20.41	5	21.44
9/16	22.96	4½	24.00
5/8	25.51	4	26.5
11/16	28.07	3½	29.20
3/4	30.62	3½	30.80
13/16	33.17	3½	34.50

TABLE 4. WEIGHTS OF STEEL PLATES PER SQUARE FOOT; THEORETICAL AND ALSO INCLUDING COMMERCIAL OVERWEIGHT ALLOWANCE.

Table 4 shows the theoretical weights of steel plates, together with the adjusted weights, the latter including the percentage for overweight, and being those which are used in estimates on steel-plate work of all kinds.

Annealing High Speed Steel

By W. Osborne

Experience with annealing high-speed steel in one hour as previously described.

A question as to how far the heating temperature can vary and still give good results.

"Have you tried the new way of annealing high-speed steel?" The speaker was making a call on one of those machine-shop superintendents who has to try new things before knowing whether they are good or not.

"We have tried quite a lot of ways. What kind of a way do you mean?" was the reply.

"Didn't you notice the way C. U. Scott does it? He tells all about it on page 813, Part 1, Volume 33, of the AMERICAN MACHINIST. It is a new one to me and I am not likely to get a chance to try it, but I wish you would look the article up and try it and let me know how it works."

In due time the article was looked up and soon afterward the old man visited the blacksmith shop and let the boss blacksmith in on the method.

"See here now. I have a new one for you. Here is the very latest, and easiest, and quickest way of annealing high-speed steel, and it is the surest way too."

A cheerful grin spread over the face of the blacksmith. "That is the very thing that I have been waiting for. I have lots of trouble along that line. It takes a lot of fussing to keep up the pieces of pipe that we pack the pieces in. They only last for a few times until they get holes burned in them. And often they are too small for some of the pieces. What is this new way anyhow?"

"Do you know how hot 1292 degrees is?"

The blacksmith looked around the shop and part of the grin vanished.

"Of course I know how hot it is, but I don't have any way of measuring it. If

I had one of them pyrometer things I could get it all right."

"We haven't got one so we will get as near as we can. You know how hot to heat a piece of carbon steel to temper it? All right. That is too hot but not so awful much too hot either, so this is the way you are to do it. You take a piece of high-speed steel and heat it up to 1300 degrees, as near as you can guess, and then let it cool down just like you would if you were going to water 'neal it. You mind that heat? Copper color in the dark is the way we used to describe it when I was a boy. Then you heat it up again to 1300 degrees and soak it along at that heat for 30 minutes. Then you throw it down and let it cool just as it wants to and it is just as soft as can be. Let me know how it works."

"I wish it would work, but I will try it anyhow, if you say so."

"You say that as though you were going to a funeral. Think of some of the dead-sure things that wouldn't work at all and be cheerful. This worked for the other fellow. If it don't work for you I will know that you don't know 1292 degrees after all." So saying, the old man passed on and left the blacksmith to his troubles.

A few hours later the blacksmith came around with a piece of steel in his hand. Part of it had been turned in the lathe.

"I have been trying that new way of 'nealing high-speed steel, and I guess it is all right. The foreman in the machine shop says it is as soft as any piece he ever tried to cut."

"Are you sure that it wasn't soft before you started with it?"

"It was hard all right. It is the stub end of a lathe tool."

"How did you do it?" This question was asked for the purpose of fixing the method in the blacksmith's mind more than for information.

"I just did as you told me; as near as I could get the heats. I heated it to a nice low red and held it there for 30 minutes, and then I let it cool down, and then I heated it up again and let it cool down slow until it was as cool as for water 'nealing, and then I stuck it in the ashes and let it lay for awhile. You said it didn't make any difference about the last cooling but to just let it cool."

"Tell me that over again."

The blacksmith repeated his statements.

"And that piece is soft, is it?" The old man seemed somewhat doubtful.

"It is soft all right. Look at it. You can see how nice and easy the tool cut it. I didn't think it would when you told me what to do."

"I had my doubts about it too, and now I am wondering how soft it would get if you tried doing it the way I told you to." The blacksmith started to say something but the old man stopped him by continuing: "You got things turned around. You should have heated it and let it run down first and then have reheated it and held it at that heat for the 30 minutes and then let it cool off. Try another piece that way."

The blacksmith did as he was requested and found that he got good results that way also.

"I can't see that it makes any difference which way it is done for both of these pieces are soft. They seemed to cut alike."

"I guess it all depends on your finding the 1292 degrees of heat and if that can vary as much as you varied the way of doing the job, it may not need to be very fine. If you are able to hit it right every time, I suppose you will think that you get the right heat every time, while I will think that it will work at almost any heat. We know that it worked twice anyhow."

Perhaps Mr. Scott can tell the limits of heat inside of which it will work and outside of which it will not.

Hardness Testing Apparatus

The larger part of one session of the American Society for Testing Materials was devoted to the discussion of hardness testing, the subject being opened by A. F. Shore in a paper on the scleroscope.

This able paper reviewed the various methods and devices used to test hardness, described the scleroscope in detail and pointed out its applications. In addition, it met the objections commonly urged against the instrument, with counter arguments.

As we have described this instrument in detail in our columns, as well as having kept step with its continual development, it is unnecessary to more than touch upon a few points of the paper.

Referring to manganese steel, which shows soft to the scleroscope, but which cannot be cut with cutting tools, Mr. Shore said: "It contains an abrasive which will at once wear off any steel tool which cuts with a scraping action like a drill or file. Manganese steel, which can absolutely not be drilled, can be cut with the greatest ease by a cold chisel, which is not even up to the standard in hardness. The action of this tool is such as to escape the abrasive effect of the manganese in this steel."

Referring to rivet steel, we find these interesting statements: "The author's experiments have shown that shear resistance of rivets, increases quite directly with the hardness increment, and taking for example an ordinary rivet which may show 21 hard as compared with another 42 hard, it would be found that the one twice as hard has about 95 per cent. more resistance to shear; 42 hard, by the way, is softer than a number of steels when they are annealed for machining, and I believe that with the proper composition, not losing sight of the condition under which the rivets have to be inserted, 45 to 50 hard is not too high and is easily possible.

"If the plates which the rivets join are a little harder than the rivet, which is usually the case, they will act as a sharpened shear under stress and will remain sharp until shearing has been accomplished, while, on the other hand, if the rivet is a little harder than the plate, the plate will lose its keen shear edge so that it would rather stretch the rivet than cut it, in which instance a much greater load can be carried. Assuming that the average construction of steel parts has a hardness of from 25 to 35, a rivet showing a hardness of from 40 to 50 would be able to destroy a good part of the keen shearing effect, besides having a much higher elastic limit."

	Scleroscope Readings.	Brinell Hardness Numbers.
Tool steel	86.1	641
Silicon steel	33.6	262
Manganese steel	29.5	179
Cast iron No. 1	33.3	149
Cast iron No. 2	32.9	172
Bessemer steel	26.6	185
High carbon steel	37.8	289
Alloy-copper 70, antimony 30	42.4	110
Alloy-copper 80, antimony 20	25.5	110.5
Alloy-copper 90, antimony 10	22.1	94.7
Copper	15	88.5

The paper closed with an appeal for the adoption of an universal standard as a measure of hardness.

Discussion was quite general and complimentary, with a trend toward pointing out the limitations of the instrument. Mr. Parker said that he had found it necessary to have the glass tube perfectly plumb, the surface piece to be tested normal to the line of impact, and all scale or decarbonized surface removed. In fact, it is wise to have the surface carefully ground.

Bradley Stoughton pointed out that on pieces that have a surface or skin hardness different from the internal hardness, the Brinell test is probably better than the scleroscope test; such pieces as case-hardened gears for automobiles, drop-hammer dies, projectiles, etc.

Another member stated from his experience that comparisons of scleroscope readings should only be made between readings from specimens of the same composition.

D. E. Douty presented a short tabulation comparing scleroscope readings and Brinell hardness numbers.

To Pay, a Device Must be Used as Intended

"Why don't you build an uptodate machine tool?" This question greeted a lathe builder as he visited the shop of a former customer. "Why," he replied, I thought I did build a modern tool. Suppose you tell me where my failures are so that I can go home and correct them."

After considerable discussion all of the objections simmered down to one, his lathes did not have a quick-change geared feed box.

A little distance from where they were standing during this conversation was a competitor's lathe that had a quick change feed device, and was set up for the finishing cut on a large cast-iron drum. The whistle had blown and the men had gone.

"Now," said the lathe builder, "the advantage of that quick-change device to you is only imaginary, and if I don't prove it there is a good dinner for you at my expense. On that drum your man ought to take a feed of an inch. I will bet you that it is really nearer 1/32 than an inch." And he was right.

Continuing, he said, "It is easy for your foreman to go around and jack up the men and shove up the quick-change feeds, and it is just as easy for the men to cut it down as soon as the foreman's back is turned. With my lathe you can gear for the proper feed for those drums and it is too much work for the man to change to something finer, and the chances of getting caught are too many. For your work my lathe is better and I guess I won't change my design."

In another part of the shop was a splendid new, powerful miller set upon some D-valves for small engines. "There," said the lathe builder, "is another example of what I just said. You are not getting any good from these devices. That mill ought to carry a feed of six inches per minute on that work, and you are not getting a chip that I can't blow off with my breath—it's nothing but cast-iron dust.

"Any of these devices in the shop is worthless unless it can be used, and is used up to its capacity."

Increasing Shop Capacities

Metal Working

News items for the sales department—where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip—facts.

The Pontiac (Mich.) Foundry Company will erect a new foundry.

Chas. J. Anderson's foundry at Menominee, Wis., was burned. Loss, $5000.

The Grand Trunk Pacific Railway will erect large shops at Quebec, Can.

The Sharon (Penn.) Steel Hoop Works is to build a band mill to cost $150,000.

The Clore plow factory, at Rising Sun, Ind., will be moved to Washington, Ind.

Hewlett Brothers, Salt Lake City, Utah, will erect a factory for the manufacture of cans.

The Michigan Pressed Steel Company, Detroit, Mich., has plans for a new factory building.

The shops of the Biwabik (Minn.) Mining Company will be enlarged at a cost of about $160,000.

The Roth Pump and Manufacturing Company, Joplin, Mo., is looking for site for a new plant.

The Russell Motor Company, Duluth, Minn., will erect an addition to be used as a machine shop.

The Bromwell Brush and Wire Goods Company, Greensburg, Ind., will erect an addition to its plant.

The E. J. Kruce Company, Detroit, Mich., has awarded contract for the erection of a two-story machine shop.

The Linderman Machine Company, Muskegon, Mich., is building a new shop to be used for erection work.

The Regal Motor Car Company, Detroit, Mich., expects to have its new building ready for machinery August 1.

The Dallas (Tex.) Consolidated Traction Company will build additional car barns and make other improvements.

General contract has been let for the construction of a new factory for the Van Dyke Motor Company, Chicago, Ill.

The Templeton, Barret Company, Menosha, Wis., manufacturing silver-plated ware, is looking for a factory location.

The Everett-Metzger-Flanders Company, Detroit, Mich., is building a four-story addition to its automobile plant No. 1.

The Brodie Manufacturing Company, Chicago, Ill., making heavy hardware, will probably erect a branch plant in Texas.

The New Britain (Conn.) Machine Company has awarded the contract for the construction of a new five-story factory.

The Los Angeles Malleable Iron and Steel Company has secured site at Long Beach, Cal., on which a plant will be erected.

The Bonney Vise and Tool Works, Allentown, Penn., has secured a permit for building a one-story machine-shop addition.

The C. A. Shaler Company, Waupun, Wis., will erect a new building to be devoted to the manufacture of electric vulcanizers.

It is reported the shops of the Eastern Bengal Railway at Kanchiapara, India, will be enlarged at a cost of about $1,500,000.

The Anthony Screw Company, Chandler street, Worcester, Mass., is in the market for radial drill and automatic screw machine.

The Wason Manufacturing Company, Springfield, Mass., building railroad cars, will build an addition to be used as a foundry.

The Watt Mining Car Wheel Company, Barnesville, Ohio, has increased its capital stock for the purpose of enlarging its plant.

The Palace Auto Station, Main street, Worcester, Mass., is building a new garage and will require light machine tools for repair shop.

The Maine Central Railroad has let contract for the construction of a new roundhouse in Waterville, Me. This is to cost $70,000.

The Nicholson File Company, Providence, R. I., has obtained a permit to build a one-story addition, which will be used for a workshop.

The Warwick Iron and Steel Company, Pottstown, Penn., will erect another furnace to have a capacity of about 2500 tons of pig iron.

The Mexican Steel Products and Machinery Company, S. A. Gante No. 1, Mexico City, Mex., is inquiring for machinery for manufacturing valves.

The Harrisonville (Mo.) Pump and Foundry Company, recently incorporated, will establish a plant for the manufacture of pumps and hard castings.

The Jennings Motor Car Company, Detroit, Mich., recently formed, has plans under way for a new plant to be erected somewhere in the Central West.

The A. E. Shorthill Foundry Company, Marshalltown, Iowa, is considering reorganization of company and removal of plant to some other location.

The American Automobile Company, Beatrice, Neb., has plans under consideration for securing site on which to erect an initial plant to cost about $75,000.

Plans are being prepared for a new factory building for the Roe Stephens Manufacturing Company, Detroit, Mich., manufacturing valves and fire hydrants.

The Hart Manufacturing Company, Hartford, Conn., has taken out a permit for the erection of a new factory. The company manufactures electrical supplies.

A. Allen, 8-10 Markham's building, St. Georges and Hout streets, Cape Town, S. A., is in the market for machinery for the manufacture of stamped steel ceilings.

James Cunningham Sons & Co., Rochester, N. Y., have engaged in the manufacture of automobiles and will erect a four-story building adjacent to their carriage factory.

The Jones Cold Store Door Company, Hagerstown, Md., will erect a new plant to contain machine, finishing and assembling rooms, iron works, galvanizing department, etc.

The Detroit (Mich.) Auto Specialties Company, now located at 909 Greenwood avenue, will erect a new two-story building for the manufacture of automobile parts and supplies.

The Lewis Brothers Brass and Machine Company, Tacoma, Wash., will reincorporate under the name of the Western Brass Works and propose erecting a new factory and foundry.

The Detroit (Mich.) United Railway Company is now erecting new car barns, repair shop, etc., and will later erect a group of shops for the manufacture, equipment and repair of cars.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids August 16, for one steam hammer for the Mare Island, Cal., navy yard, as per Schedule No. 2695.

The Norton (Va.) Car and Foundry Company has purchased site adjoining its present plant and will erect a foundry and machine shop for building mine cars and doing general repair work.

The American Writing Machine Company, 345 Broadway, New York, has leased a factory building on Mulberry street, Newark, N. J., recently vacated by the Universal Talking Machine Company.

The Elgin, Joliet & Eastern Railway Company will let contracts soon for proposed new buildings at East Joliet, Ill. These include steel car shop, wood car shop, locomotive shop, roundhouse, etc.

General Manufacturing

The Griffin Gin Company, McKinney, Tex., will erect a gin.

The Wallaceburg (Ont.) Sugar Company is doubling its plant.

The Wallaceburg (Ont.) Glass Works will enlarge its plant.

A new municipal light plant is to be built at New Concord, Ohio.

Souris, Manitoba, will spend $95,000 for new waterworks machinery.

The Goodall Worsted Company, Sanford, Me., will build an addition.

The Bain Wagon Company, Woodstock, Ont., is extending its plant.

Prince Rupert (B. C.) will spend $75,000 on a new electric-light plant.

The A. H. Berry Shoe Company, Portland, Me., will build a new factory.

The William Rahr Sons Company will erect a brewery at Manitowoc, Wis.

Kelley & Sons will erect a crate factory at Gainesville, Fla., to cost $50,000.

Bonds for $10,000 were voted for an electric-light plant at Aurora, Minn.

The Dominion Shingle Mill will equip a lace factory at Aldergrove, B. C.

The Keystone Pottery Company, Crooksville, Ohio, is enlarging its plant.

The Phœnix Knitting Company, Milwaukee, Wis., will erect an $80,000 addition.

The Sherbrooke (Ont.) Street Railway Company is building a new power house.

The Canada Woodenware Company is building a large factory at South Bay, Ont.

The Yarmouth (Me.) Manufacturing Company is in the market for an engine.

The city of New Haven, Ky., will construct waterworks. Address the mayor.

Belleville, Ont., will purchase large quantities of new water-pumping machinery.

The Cabot Manufacturing Company, Brunswick, Me., is to build a new power house.

The Keever Starch Company, Columbus, Ohio, is erecting three additions to its plant.

Ole Bjella, of McIntosh, Minn., will build an addition to his sleigh and harrow factory.

The Brampton Woolen Company, Newport, N. H., will double the capacity of its plant.

Alexander City, Ala., will vote on $12,500 bond issue for extension to its water mains, etc.

The Independent Telephone Company will build a new central station at Zanesville, Ohio.

Plans are being prepared for new municipal waterworks system for New Lexington, Ohio.

The United Illuminating Company, Bridgeport, Conn., is erecting an additional boiler house.

The Salem (Mass.) Electric Light Company will make extensive improvements to its plant.

The city of Leitchfield, Ky., contemplates the construction of waterworks. Address the mayor.

The Selzer Heating Company, Akron, Ohio, will equip a new plant at 42 North Howard street.

The plant of the West Side Electric Company, at Maricopa, Cal., will be greatly enlarged.

The Farmers Grain and Milling Company, St. Henry, Ohio, capitalized at $30,000, will build an uptodate flour mill and grain elevator.

The Dennison Company, South Framingham, Mass., is in the market for electric motors.

Fire destroyed the butter-dish factory of Wm. Beitner & Son, at Sidnaw, Mich. Loss, $25,000.

The Laurentide Mica Company, Lincoln, Neb., is looking for suitable site for a branch factory.

The planing mill of Milton Landis, Coopersburg, Penn., was destroyed by fire. Loss, $10,000.

The Pond Lily Company, New Haven, Conn., cotton goods bleachers, will enlarge its plant.

The council at Marshall, Minn., is arranging for the establishment of a heat-distributing system.

The King & Queen mine, at Carter, near Wallace, Idaho, plans the erection of a 75-ton concentrator.

The Cary Canning Company, Sturgeon Bay, Wis., is looking for a suitable site for a new plant.

The British Columbia Packers' Association will erect a $40,000 plant at New Westminster, B. C.

The O'Donnell Shoe Company, St. Paul, Minn., will erect a factory at Sibley and Tenth streets.

The Dallas (Tex.) Light and Power Company will make extensive improvements in its power plants.

The New England Sanotorium, Melrose Highlands, Mass., is in the market for a deep-well pump.

L. W. Kerney & Co., Chicago, Ill., manufacturing asbestos goods, will erect a three-story addition.

City of Sylvania, Ga., will open bids July 20 for the construction of waterworks. A. B. Lovett, mayor.

The American Encaustic Tiling Company, Zanesville, Ohio, will make improvements to its power plant.

The Kearns-Gorsuch Bottle Company, Zanesville, Ohio, will make improvements at a cost of $150,000.

W. W. Woodruff & Sons, Mt. Carmel, Conn., has awarded contract for the erection of a boiler house.

The J. B. Williams Company, of Glastonbury, Conn., soap manufacturers, is erecting an additional factory.

Fire destroyed the plant of the Manhattan Ribbon Company, Paterson, N. J., causing a loss of over $250,000.

N. D. Swain, Girard, Kan., is interested in the erection of a large plant for the manufacture of bricks, etc.

The British Columbia Electric Company will spend $10,000,000 in developing power near Vancouver, B. C.

The Crystal Knitting Mills Company, Slatington, Penn., is building an addition which will double its output.

The cement and brick plant of the Meacham & Wright Company, Chicago, Ill., was burned. Loss, $85,000.

The plant of the Ohio & Western Lime Company, at Huntington, Ind., was destroyed by fire. Loss, $150,000.

The directors of Cambridge (Mass.) Y. M. C. A. are taking prices on boiler-room equipment for a new building.

Fire destroyed the plants of the Orin Lumber Company and the Reliance Lumber Company, at Tacoma, Wash.

The Mills Woven Cartridge Belt Company, Worcester, Mass., is in the market for vacuum-cleaning apparatus.

The Wilkes-Barre (Penn.) Lace Manufacturing Company is having plans prepared for an addition to its plant.

The National India Rubber Company, Bristol, Conn., will reopen its plant, which has been closed for some time.

The Mechanical Rubber Company, Providence, R. I., will reopen its plant, which has been closed for several years.

The Woonsocket (R. I.) Rubber Company will commence operations soon, its plant having been idle for several years.

The Mercer & Ferdon Lumber Company, Grand Rapids, Mich., is erecting a factory to be used for making interior finish.

Fire destroyed the plant of the Forge Coal Mining Company, at Portage, Penn., causing a loss of $25,000. Will be rebuilt.

The Specialty Manufacturing Company, Melrose, Mass., making furniture specialties, is looking for a site for a new plant.

The Maqua Printing Company, Schenectady, N. Y., will erect a new $50,000 building to be equipped with modern machinery.

W. Starling Burgess, of Marblehead, Mass., is trying to secure site on which to erect a plant for the manufacture of aeroplanes.

The Lindner Interior Manufacturing Company, Grand Rapids, Mich., is building a two-story addition to be used as a finishing room.

The Segerstrom Piano Company, Minneapolis, Minn., is considering offers for removing its plant. The company needs more room.

The Hartford (Conn.) Electric Light Company has secured permit for the erection of two additions to its power plant at Dutch Point.

Two new 3-ton traveling steam cranes will be purchased by the Bombay, Baroda & Central India Railway. General offices are at Bombay.

Paul B. Fant, Newark, Ohio, is interested in the erection of a new plant for the manufacture of a new magneto appliance for automobiles.

The city council, Leslie, Ark., granted franchise to J. W. Vaughn and James F. Kiser, to construct waterworks and electric-light plant.

It is reported that Fellow Brothers, Detroit, Mich., whose saws and planing mill recently burned, are considering rebuilding same in some other locality.

Twenty thousand dollars' worth of machinery, destroyed by fire in the Alaska Bedding Company's plant at Winnipeg, Man., will be replaced immediately.

The Gloucester (Mass.) Electric Company is considering the installation of two 500-horsepower water-tube boilers to replace the return-tubular boiler now in use.

The Anniston (Ala.) Chamber of Commerce has made arrangements for the location of

the Lubin Manufacturing Company, which will manufacture woodworking specialties.

Fire damaged the plant of the Wortman-Ward Company, London, Ont., to the extent of about $20,000. The company manufactures washing machines, wheelbarrows, etc.

The Jos. Banigan Rubber Company, Providence, R. I., whose plant has been closed for several years, will resume operations in the Fall. $1,000,000 will be expended in improving its plant.

The International-Acheson Graphite Company, Niagara Falls, N. Y., will soon award contract for the construction of an addition, which will have room for ten or twelve additional furnaces.

Frederick Bachman, 28 Abbotsford avenue, Newark, N. J., has plans under way for building a new aëroplane and is said to be interested in the organization of a company for backing the project.

Proposals will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until 11 o'clock a.m., July 30, for condensers, piping, equipment, etc., for power plant at New York navy yard.

The Holley Cold Storage and Fruit Company is now being formed at Holley, N. Y., for the purpose of erecting a cold-storage plant which will be erected on Albion street on property owned by W. S. Housel.

The Windshield Manufacturing Company, formerly of Brooklyn, N. Y., has leased part of the factory of the Newark Rivet Works, on Lafayette street, Newark, N. J., for the manufacture of windshields for automobiles.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids August 9, for installing two exhauster systems as per Schedule 2671, and August 16 for one water-tube boiler (schedule 2696).

The Bangor Royal Quarry, at East Bangor, Penn., owned by the Robert S. Brown Estate, which has not been in operation for sometime, has been leased by C. S. Ford, and preparations are being made for its reopening.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., August 8, for fixed irons for rising stem gate valves, cylindrical valves and snubbing hooks and girders for the canal locks, as per Circular No. 594.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., August 5, for centrifugal pumps, steel castings, locomotive and truck springs, steel links for cross conveyer, nonliquid oil, cable grease, etc., as per Circular No. 595.

The Twentieth Century Wheel Company, Indianapolis, Ind., recently formed, is planning the erection of a new plant on site to be secured in the South for the manufacture of a new design of hubs for automobiles. W. E. Woodhouse is interested.

A company has been formed by W. S. Paterson, H. J. Nuler, J. H. Farley and others, of Flint, Mich., for the manufacture of aëroplanes. The company has secured temporary quarters in the building occupied by the Fleetwood Engineering Company.

The Oklahoma Bag and Cotton Mills, of Oklahoma City, capitalized at $1,000,000, will build a plant for spinning yarns, weaving bag cloth, making bags, bleaching, finishing, etc. M. L. Berry, formerly with the Mills Manufacturing Company, of Greenville, Okla., is president and general manager.

Proposals will be received at the office of constructing quartermaster, Fort Missoula, Mont., until 9 o'clock a.m., July 30, for the construction of pumping station and installation of boilers, steam pumps, valves, etc. Alternate bids will be received for pumping station using motor-driven pumps. Information can be had of A. B. Shattuck, fourth infantry constructing quartermaster.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids August 2, for 3024 gallons fuel oil (schedule 2689), brass and copper pipe (schedule 2690), 19,000 pounds steel bolts and nuts, 1100 quires emery cloth, 3 sets taps and dies, 26 bench vises, 78,000 pounds billet steel (schedule 2691), brass nuts and rivets, 725 pounds copper rivets, 2000 pounds rod brass, 7350 pounds sheet brass, 300 pounds phosphor bronze, 2000 pounds sheet copper (schedule 2690).

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids July 19 for five generators (schedule 2675), stud bolts and nuts (schedule 2684), 2200 pounds deck bolts and nuts, 4800 pounds steel bolts and nuts, ten sets twist drills, 20 dozen twist drills, 936 files, six grindstones, steel tapes, taps and dies, 36 gasolene torches, 2100 pounds galvanized iron washers (schedule 2683), 2800 pounds solder, 3900 pounds nickel steel, 30,000 pounds sheet boiler steel (schedule 2684), 35,100 pounds galvanized sheet steel (schedule 2682); July 26—Desk and bracket fans, telephone supplies (schedule 2692).

New Incorporations

Glenn Valve Manufacturing Company, Chicago, Ill. Manufacture and deal in valves and machinery.

The Winsted Hardware Corporation, Winsted, Conn. Capital, $100,000. Thurlow H. Bronson, president.

Bridgeport Window Hardware Company, Bridgeport, Conn. Capital, $300,000. Incorporators, Fred Carpenter, Wm. C. Russell, J. H. Crossley.

Simms Magneto Company, New York. Manufacture magnetos, etc. Capital, $1,000,000. Incorporators, V. D. Hecht, H. M. Kelbarn, A. Nathan, etc.

Anchor Pottery, Trenton, N. J. Manufacture pottery, etc. Capital, $250,000. Incorporators, Wm. J. Burke, Arthur A. Jones, Harry L. Jones.

Weber Furniture Company, Chicago, Ill. Manufacture furniture. Capital, $50,000. Incorporators, Henry F. Weber, Max Guthman, Frank H. Bicek.

Imperial Tanning Company, Chicago, Ill. Manufacture leather, etc. Capital, $25,000. Incorporators, Albert Martin, A. A. McClananan, B. McWilliams.

Office Appliance Company, Providence, R. I. Manufacture stamp affixing machines. Capital, $100,000. Incorporators, Edwin C. Bliss, S. B. White, George Kollstede.

Fisher Aero-Craft Construction Company, New York. Manufacture air crafts of all kinds. Capital, $100,000. Incorporators, P. J. Fisher, K. S. Bates, H. A. Herold.

Imperial Storage Battery Company, Portland, Me. Manufacture and deal in batteries, electrical machinery, engines, etc. Capital, $4,000,000. Clarence E. Eaton, president.

Munsing Motor Car Company, New York. Manufacture automobiles, motor boats, etc. Capital, $500,000. Incorporators, W. H. Bursmith, M. T. Westcott, F. W. Mitchell.

Stromeyer Brake Shoe Company, Camden, N. J. Manufacture brake shoes and machinery. Capital, $100,000. Incorporators, J. Stromeyer, C. A. Harris, Jr., H. G. Pendle.

Troy Scale Company, Troy, N. Y. Manufacture weighing devices, cutlery, etc. Capital, $100,000. Incorporators, F. A. W. Kelley, D. Elden, Watervliet; N. M. Hall, Troy.

Wattles Stoking Register Company, Providence, R. I. Manufacture stoking registers, boiler and steam appliances. Capital, $50,000. Incorporators, Cyra B. Wattles, Dexter B. Potter, etc.

Interior Metal Manufacturing Company, Jamestown, N. Y. Manufacture metal furniture. Capital, $150,000. Incorporators, Gustaf Carlson, Oscar C. Carlson, Chas. A. Chindgren, etc.

Albany Lock and Seal Company, Albany, N. Y. Manufacture car locks and seals, etc. Capital, $50,000. Incorporators, J. MacKenzie, Watervliet, N. Y.; W. A. & C. H. Humphrey, Albany.

Ventrite Manufacturing Company, Jersey City, N. J. Manufacture window sashes, etc. Capital, $100,000. Incorporators, C. E. Borden, C. C. Randolph, Plainfield, G. Kabureck, Jersey City.

Sapphire Record and Talking Machine Company, New York. Manufacture and deal in talking machines, records and supplies. Capital, $100,000. Icorporators, P. B. Verblanck, M. Wagner, D. Tauber.

Valve Seating Tool Company, Fairfield, Conn. Manufacture engines, machinery, tools, etc. Capital, $50,000. Incorporators, J. Walter Perry, Wm. D. Sherwood, B. A. Bulkley, all of Southport.

Smith Tractor Manufacturing Company, Chicago, Ill. Manufacture and sale of machinery, tools, etc. Capital, $25,000. Incorporators, Addison L. Gardner, Geo. B. Williams, Carroll H. Jones.

Haskins Boiler Company, New York. Manufacture and deal in stoves, radiators, heating supplies, etc. Capital, $50,000. Incorporators, E. O. Haskins, Rutherford, N. J.; C. H. Chaffee, T. G. Privlean, New York.

Hampshire Manufacturing Company, New York. Manufacture and deal in machinery, tools and appliances. Capital, $125,000. Incorporators, C. J. Kleber, New York; J. MacGregor, Springfield, Mass. J. H. Kaesen, New York.

Mackey Water Motor Pump Company, Silver Creek, N. Y. Manufacture automatic water pumps. Capital, $50,000. Incorporators, F. W. Mackey, A. A. Mackey, C. B. Livermore, Silver Creek; G. C. Carey, Cattaragus.

Hazard Motor Manufacturing Company, Gates, N. Y. Manufacture marine and automobile gas engines, general machinery, manufacturing business. Capital, $400,000. Incorporators, E. C. Hazard, G. E. Hazard, J. F. Alden, Rochester, N. Y.

Business Items

Contracts were awarded June 27 for the construction of the new plant of the Kempsmith Manufacturing Company, at Forty-fifth avenue and Rogers street, West Allis. A spur track from the Chicago & Northwestern Railroad has been completed to the site of the buildings, and ground for the plant proper was broken Tuesday, July 5, and the expectations are that they will be running in the new plant by November 1. There will be four buildings. Main building will be initially 250x200 feet, with a wing 100x100 feet, and ultimately will be extended to 500 feet long. It will be of saw-tooth construction, concrete foundation and floor, and brick walls. The pattern shop is a separate building 50x90 feet, absolutely fireproof. The power plant, 50x100 feet, also fireproof, and to contain two 100-horsepower boilers and a 200-horsepower Corliss engine, direct connected to a 150-kilowatt generator. Office building will be 40x60 feet, two stories and basement, brick and faced stone. All new equipment to be needed in new plant has been contracted for.

TRADE CATALOGS

Hoefer Manufacturing Company, Freeport, Ill. Circular. Connecting rod, drilling and facing machine. Illustrated.

Castolin Company of America, 1610 Wright building, St. Louis, Mo. Catalog. Castolin process for welding cast iron. Illustrated, 16 pages, 9x11½ inches, paper.

Huther Brothers Saw Manufacturing Company, Rochester, N. Y. Catalog. Circular, band and milling saws, saw-fitting machinery. Illustrated, 80 pages, 5x7 inches, paper.

Celfor Tool Company, Buchanan, Mich. Catalog No. 10. Celfor drills, reamers, Rich flat drills, quick-change chucks, reamer sockets, grinding machinery. Illustrated, 30 pages, 6x9 inches, paper.

The Bristol Company, Waterbury, Conn. Bulletin No. 150. Recording instruments for pressure, temperature and electricity, pyrometers for high temperatures. Illustrated, 64 pages, 8x10½ inches.

FORTHCOMING MEETINGS

Joint meeting of American Society of Mechanical Engineers and Institution of Mechanical Engineers, Birmingham, England, July 26-29, 1910.

Society of Automobile Engineers, convention of designers and superintendents, July 28, 29 and 30, Detroit, Mich. H. E. Coffin, president 1451 Broadway, New York City.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. P. Clark, secretary, 309 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania; monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland; monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

MISCELLANEOUS WANTS

Caliper catalog free. E.G.Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

If you want special machinery or tools designed, I can give you satisfactory service. Box 694, AMERICAN MACHINIST.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Light or medium weight machinery to manufacture on contract or special machinery to build. Box 734, AMERICAN MACHINIST.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 990 G St., Washington, D. C. Write for Inventor's Handbook.

Mechanical drafting, special machinery designed, tools, dies, fixtures, etc.; charges reasonable. Box 669, AMERICAN MACHINIST.

Wanted—Work for first class machine shop; light, fine special machinery, tools, jigs and experimental work. Boyce, 584 Hudson St., New York City.

Light, fine machinery and mechanical specialties built to order; jigs, tools, etc., designed and built. Goodson Electric and Manufacturing Co., Providence, R. I.

A well equipped machine shop within 30 miles from New York solicits orders for all kinds of machine work. Send inquiries: The Brunswick Refrigerating Co., New Brunswick, N. J.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Wanted—A concern consisting of foundry and machine shop, employing 150 to 200 men, would like to enlarge its business by manufacturing machines for other parties; estimates given. Box 662, AMER. MACHINIST.

A machine shop located near New York or Philadelphia, well equipped with modern tools and appliances, say from a 36-inch planer down, and wishing additional work, should write, giving general information regarding location and equipment. Address Box 729, AMERICAN MACHINIST.

Oxygen-acetylene welding of all kinds of metals; crane facilities for handling the heaviest of pieces; we do light work also; our experience and success warrant us in giving a very liberal guarantee covering all of our work. Krajewski-Pesant Company, 52 Beard St., Brooklyn, N. Y.

Italy—Wanted: Agency of large American firm that wishes to begin or develop important business in Italy; good occasion Universal Exhibition Turin, 1911. (Office, 41 Union Square, 1014, New York). Bernoulli & Cabibi, Turin. House founded 1878. First-class references in United States.

Machine work wanted; we are in a position to manufacture special or staple articles in connection with our present line. Our facilities are such that we can employ one hundred and fifty men if necessary; our equipment also includes large case-hardening and tempering furnaces. Address H. G. Kotten Co., 30 Church St., New York City.

Machinists' and draftsmen's handbook; second edition, enlarged and revised; over 450 pages, including illustrations and tables for $2.50; from cover to cover it is full of valuable and helpful information; invaluable to the employer as well as the workman; don't send any money; simply send your order and receive the book on trust; look it over—if you like it, keep it; act today. Address Peder Lobben, Box 243, Holyoke, Mass.

Wanted—Some light work in metal manufacturing by a progressive Massachusetts company who are at present turning out a high-grade mechanical product and have been doing so for over forty years; we employ one thousand hands and have a thoroughly modern plant with uptodate machinery and facilities; we would not consider anything but a large and steady contract from thoroughly reliable parties; correspondence solicited. Address "Facilities," Box 535, AMER. MACH.

HELP WANTED

Classification indicates present address of advertiser, nothing else.

COLORADO

Due to the steady increase of our business, we are constantly in need of drill press, lathe, planer, grinder, Jones & Lamson and bench men; also toolmakers and tool smiths; good climate and location; steady work, good pay to first-class men; shop clean, light and well ventilated; 9 hours work. Address, stating experience. J. Geo. Leyner Engineering Works Co., Littleton, Colo.

CONNECTICUT

Wanted—Salesmen to handle on a generous commission basis, a well advertising and quick selling line of lathe tools; commissions given on all orders received from prescribed territory; send references with reply. Address "R. T.," AMERICAN MACHINIST.

Wood patternmakers, toolmakers wanted; first-class patternmakers on automobile work; also experienced toolmakers on automobile tools, jigs, fixtures and gages; highest wages paid. Apply, Factory Office, The Pope Manufacturing Company, Hartford, Conn.

ILLINOIS

We invite applications from first-class machinists, machine and floor men; steady work for first-class men; preference will be given married men who will move their families and stay permanently. The Ingersoll Milling Machine Co., Rockford, Ill.

Wanted—General storekeeper; a young man experienced in organizing stockrooms and arranging and classifying materials in systematic manner; we want an executive with energy and ability to handle stock keeping system and get results; fine opportunity. Address, giving age, experience in full, and wages desired. Box 699, AMER. MACHINIST.

INDIANA

Wanted—A first-class tool and diemaker by an old established manufacturing concern located in the Middle West, one who has had experience in deep drawing and stamping tin plate specialties; steady work and good opportunity for advancement if deserved; state experience had, age, if married or single. Address "M. F. G. R.," AMERICAN MACHINIST.

Wanted—Foreman to take charge of assembling and testing department in one of the most modern, uptodate automobile engine shops in the country; product is thoroughly established and the job will be steady for the right man; none but men who have had experience as foreman and who can furnish first-class references need apply. For full particulars address "Motor Assembler," Care AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Toolmakers, experienced on punch and die work. Apply Employment Department, General Electric Co., Pittsfield, Mass.

Man, experienced as foreman of gear cutting jobbing work; state age, experience and wages expected. Boston Gear Works, Norfolk Downs, Mass.

MICHIGAN

Wanted—A few first-class toolmakers experienced on die, jig and fixture work for light manufacturing. Box 592, AM. MACH.

NEW JERSEY

Wanted—First-class machinists, lathe, planer and boring mill hands. Box 709, AM. MA.

Wanted—A-1 automatic operator on Cleveland machines; must be well recommended. Hartford Suspension Co., 156 Bay St., Jersey City, N. J.

Old established machine shop, manufacturing sheet metal working machinery, wishes to receive applications from men qualified for foremanship. Address "Foreman," Box 713, AMERICAN MACHINIST.

Draftsman Wanted—One accustomed to laying out and building machine tool jigs and fixtures; must be man of experience. Apply at the works of Henry R. Worthington, Harrison, N. J. Call for works manager.

Draftsman—Agricultural implement factory; a young man with some practical experience or a technical graduate who desires to connect with a growing business; state age, experience, salary expected and name references. Box 732, AMERICAN MACHINIST.

NEW YORK

Designer wanted for tools and special machinery for small interchangeable work; state experience, age and salary expected. Box 707, AMERICAN MACHINIST.

Assistant purchasing agent to handle bar and sheet metals in department buying for twelve factories, advise fully regarding previous positions, salary received and expected, age, etc. Box 724, AMERICAN MACHINIST.

Wanted—First-class lathe, drill press and milling machine operators for both night and day work; state past experience, wage demanded and complete information in first letter. The Kirkham Motor Mfg. Co., Bath, N. Y.

Wanted—Good all-around boiler and plate shop layerout, capable of handling a small force, and first-class machinery to best advantage; give references for past five years, state age and wages received. Box 731, AMERICAN MACHINIST.

Assistant purchasing agent to handle castings, forgings, stampings, springs, bolts and other metal products in department buying for twelve factories; advise fully regarding previous positions, salary received and expected, age, etc. Box 725, AMER. MACH.

Salesman wanted to introduce mechanical tool; should be familiar with screw machine practice; unless you possess standing and experience in selling it will cost us to develop you and we will not stand all of the expense; to receive attention, state age, experience and salary expected. "Equipped," AMER. MACH.

A large concern contemplates the installation of a complete machine shop for the manufacture of a line of bakers' machinery; they require the services of an experienced man who is capable of starting a venture of this kind; this is a grand opportunity for a man to grow up with the business. Address Box 744, AMERICAN MACHINIST.

Wanted—By large manufacturing concern in central New York, man familiar with steam and electrical power plants, millwright work, piping, etc., also general plant up-keep; must be a good executive and able to lay out and supervise work in master mechanic's department when required; give experience, age and salary expected. Box 737, AM. MA.

Wanted—General foreman to take full charge of old established factory in New York City, employing about 100 hands in general mechanical and electrical manufacturing, light machinery, etc.; must be able to prepare estimates and be familiar with factory systems. Reply, giving full particulars of past experience, salary expected and any other details of interest. W. G., AM. MACH.

Wanted—We are constantly increasing our force and invite applications from the following: Machinists, lathe hands, screw machine hands, grinder hands, milling machine hands, motor assemblers, toolmakers, sheet metal die men; we run a nine hour shop, have desirable surroundings, and offer steady position to desirable characters. Address Superintendent, Maxwell-Briscoe Motor Co., Tarrytown, N. Y.

OHIO

Foundry foreman wanted for 200 men on engine and jobbing work; state age, experience and reference. Box 728, AMER. MACH.

Wanted—Superintendent for saw shop; 40 per cent. mechanical ability, balance hustle; a young man preferred. "Opportunity," AMERICAN MACHINIST.

Foreman for a machine shop tool room with a concern employing 900 men, on engine work; state age, experience and reference. Box 701, AMERICAN MACHINIST.

Wanted—Several first-class draftsmen with experience on crane work; none others need apply; state age, experience and salary. Box 727, AMERICAN MACHINIST.

Wanted—Foreman to assume entire charge of brass finishing department in large manufacturing concern, making a complete line of standard brass valves. Box 671, AM. MACH.

First-class molder wanted to instruct apprentices and handy men on jobbing and engine work; open shop, no labor troubles of any description; state age, experience. Box 735, AMERICAN MACHINIST.

Wanted—First-class draftsman on jigs and fixtures, also patternmakers, toolmakers and machinists for four cylinder motors; state experience and wages expected in first letter. The Findlay Motor Co., Findlay, O.

Wanted—A Cincinnati concern want a thoroughly competent and experienced mechanical designer with some knowledge of electrical work; no other need apply; permanent position and chance for advancement to right man; state experience and give references; salary at start $100 per month. Box 733, AMERICAN MACHINIST.

Superintendent—A business, employing 500 men, consisting of pattern, foundry and machine shop, manufacturing medium heavy machinery, desires superintendent with thorough knowledge of foundry and machine business; man must be systematic, and have held successfully position of superintendent in a modern organization; good salary and future with an expanding company; only men of ability need apply; location northern Ohio. Box 650, AMERICAN MACHINIST.

Wanted—First-class machinists, toolmakers die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood patternmakers, brass molders, polishers, buffers, finishers, spinners, millwrights, hammermen and blacksmiths who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Bldg., Cleveland, O.

OREGON

Wanted—Competent machinists (strictly non-union) may secure steady work at wages from $3.50 up to $4.50 for 9-hour day; high grade work with modern tools in a comfortable, well lighted shop located in the finest country in the United States. Willamette Iron & Steel Works, Portland, Ore.

PENNSYLVANIA

Foreman of machine shop for drop-forging plant. Box 747, AMERICAN MACHINIST.

Wanted—Floor hands and fitters on machine tool work. Colburn Machine Tool Co., Franklin, Penn.

Wanted—Lathe, boring mill and floor hands; good wages, steady work. The Blaisdell Machinery Company, Bradford, Pa.

Wanted—Three first-class tool and diemakers; steady position and good wages to right men. Burke Electric Co., Erie, Pa.

Wanted—Two first-class diemakers, who are accustomed to sheet metal work; steady work; good wages. Box 722, AMER. MACH.

Wanted—Toolmaker for making die sinkers' tools, for drop-forged automobile parts; state experience in detail. Western Tool & Forge Co., Brackenridge, Pa., Pittsburg district.

Steel Salesmen—We want several general steel salesmen of experience and ability; experienced in high-speed steel, alloy and crucible carbon steels; this opportunity is a most excellent one for the right men, who are qualified in every respect to become high-grade sales managers. Address "V. A. S.," AMERICAN MACHINIST.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

WASHINGTON

Wanted—By large engineering works in Seattle, Wash., engaged in marine and land work, first-class engineering draftsman who has had experience in designing machinery and boilers; none but first rate men need apply; references required. P. O. Box 1905, Seattle, Wash.

WISCONSIN

Shop man who understands the rapid and accurate production of small, interchangeable parts, and who has a good knowledge of production of stampings; must be sober, energetic and good mechanic; state age, experience, salary expected, where employed at present, and reasons for desiring a change. "X. Y. Z," AMERICAN MACHINIST.

FOREIGN

Werkzeugmaschinen- & Werkzeugfirma in Wien sucht zu möglichst sofortigem Eintritt einen Reisenden für die Balkanstaaten, welcher in erstklassigen Werkzeugmaschinen & Werkzeugen amerik. Provenienz gute Branchekenntnisse und Erfolge aufzuweisen hat: Ausführliche Offerte mit Zeugnisabschriften, Angaben über Militär- & Familienverhältnisse, Sprachkenntnisse, Religion, Alter, Gehaltsansprüche, ect. und Bild erbeten an. Box 736, AMERICAN MACHINIST.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Experienced, practical, systematic, superintendent in charge of a large manufacturing plant, wishes to make a change. Box 686, AMERICAN MACHINIST.

Position as assistant superintendent wanted by mechanical draftsman; age 33; 8 years' practical workshop experience and 9 years at drafting (reached the limit of salary), on machine tools, general engineering, shop layouts and special machinery and tools. Box 743, AMERICAN MACHINIST.

MICHIGAN

Position as foreman or assistant; drop-forge shop experience. Box 748, AM. MACH.

Wanted—Position as works accountant, cost accountant, production engineer or factory systematizer in an automobile factory, or a manufacturing company making a special line of apparatus by a man who knows all the latest and most approved systematic methods of getting results and who can focus the details of the entire plant on the manager's desk, in the most economical manner; advertiser is considered an expert on factory system and has made good in all positions filled and is presently filling an important position with a large manufacturing company, but desires to make a change; location no object. Box 746, AMER. MACHINIST.

NEW JERSEY

Tool designer wishes change; all-around toolmaker and draftsman, technical training; charge of tool work or master mechanic. Box 718, AMERICAN MACHINIST.

Superintendent and works manager by high class production engineer, expert on efficiency methods of organizing help and engineering the reduction of costs and raising of outputs; mechanical engineer by profession; expert at tools, dies, machinery and estimating; good reference for past performance. Address "Production," AMERICAN MACHINIST.

NEW YORK

As superintendent or works manager, practical shop and foundry man; a hustler. Box 738, AMERICAN MACHINIST.

Designer, experienced on automatic and special machinery, capable of taking charge of work. Box 721, AMERICAN MACHINIST.

Experienced automatic machine designer with executive ability; inventive; expert on intricate work; handling paper a specialty; desires to change. Box 726, AMER. MACH.

A-1 mechanic with broad experience on experimental and model work, tools and high-class intricate machinery; makes own drawings; excellent references. Box 730, AM. M.

General foreman, middle age, now employed, latest methods, engineering, electrical and general machinery; A-1 hustler; can handle force with executive ability. Box 715, AMERICAN MACHINIST.

Foreman machinist with executive ability wishes position; experienced on engines and machinery of all kinds; extensive experience in handling help; excellent references. S. T., 5124 Ninth Ave., Brooklyn, N. Y.

Superintendent, experienced in telephone, electrical apparatus and metal novelty manufacturing, first-class organizer and executive, no proposition too large, can furnish best of references, open for engagement. Box 749, AMERICAN MACHINIST.

Factory superintendent, extensive practical experience in the manufacturing of novelties, small machinery, tool and instrument work; executive ability, wants steady position; New York or New Jersey preferred. Box 742, AMERICAN MACHINIST.

PENNSYLVANIA

Expert mechanical engineer with wide experience, accustomed to large works, thoroughly versed in designing, organiaztion, purchase and layout of tools, increasing production in machine shop, foundries and manufacturing plants, desires position. Box 745, AM. M.

Position wanted as superintendent or foreman with a reliable firm in the manufacturing of plumbing supplies, general brass and iron goods; have 18 years' experience; familiar with uptodate tools and machines; a hustler; sober and steady practical mechanic; A-1 references; city or country. Box 723, AMERICAN MACHINIST.

FOR SALE

For Sale—Interest or control in manufacturing business; exceptional opportunity for manager or instrument maker. Box 516, AMERICAN MACHINIST.

For Sale—250-horsepower Fishkill Corliss engine; A-1 condition; seen in all its details at Ward & Upright Engineering Co.'s shop, 41 York St., Brooklyn. F. Schmidt, owner.

For Sale—Ocean wave coloring compound, for case and pack hardening; produces an indestructible golden brown and blue finish; dissolved in quenching bath. Address Young & Co., 105 N. Third St., Newark, N. J.

For Sale—McIntosh-Seymour vertical cross-compound non-condensing engine; cylinders 16" and 28" with stroke 24"; direct connected to Stanley three-phase alternator, inductor type, 440 volts, 60 cycle; we have been taking 500 horsepower from it. The Davis Sewing Machine Co., Dayton, Ohio.

For Sale—Three return tubular boilers, manufactured by Riter Bros., Buffalo, N. Y. Drums 72x16 feet 0 inches; each boiler with sixty-six 4-inch tubes; inspected by Travelers Indemnity Company, of Hartford, Conn; 93 lb. steam pressure; boilers in good condition; can be delivered in two to three months, and seen in operation at Buffalo Bolt Company's plant, North Tonawanda, N. Y.

For Sale—One Nash gas engine, 20 horsepower, two cylinder, for electric lighting, pumping or power; one Beaman & Smith horizontal boring mill; table 25 inches wide, 36 inches long; will bore 12 inches diameter, 24 inches long, and face 20 inches diameter; one 300 light J. B. Colt Co. acetylene gas apparatus. The above machines are in excellent condition, having been very little used. For further particulars and prices apply to Rider-Ericsson Engine Co., 35 Warren St., New York.

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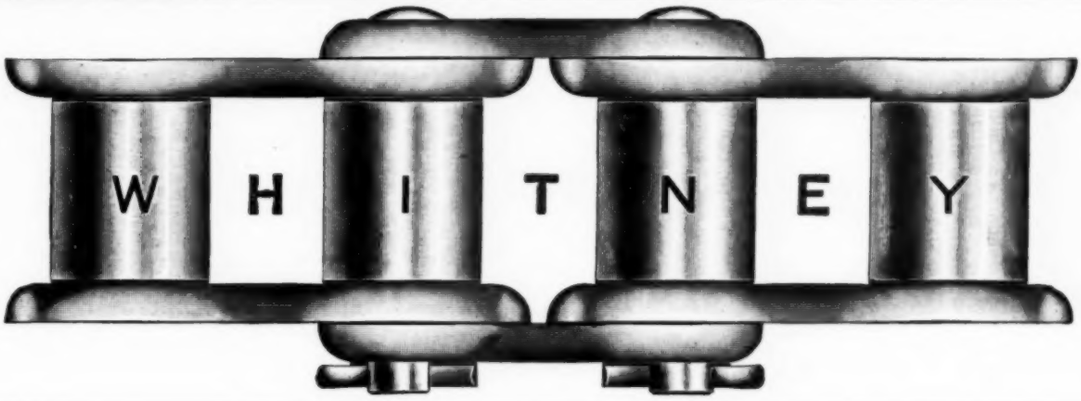
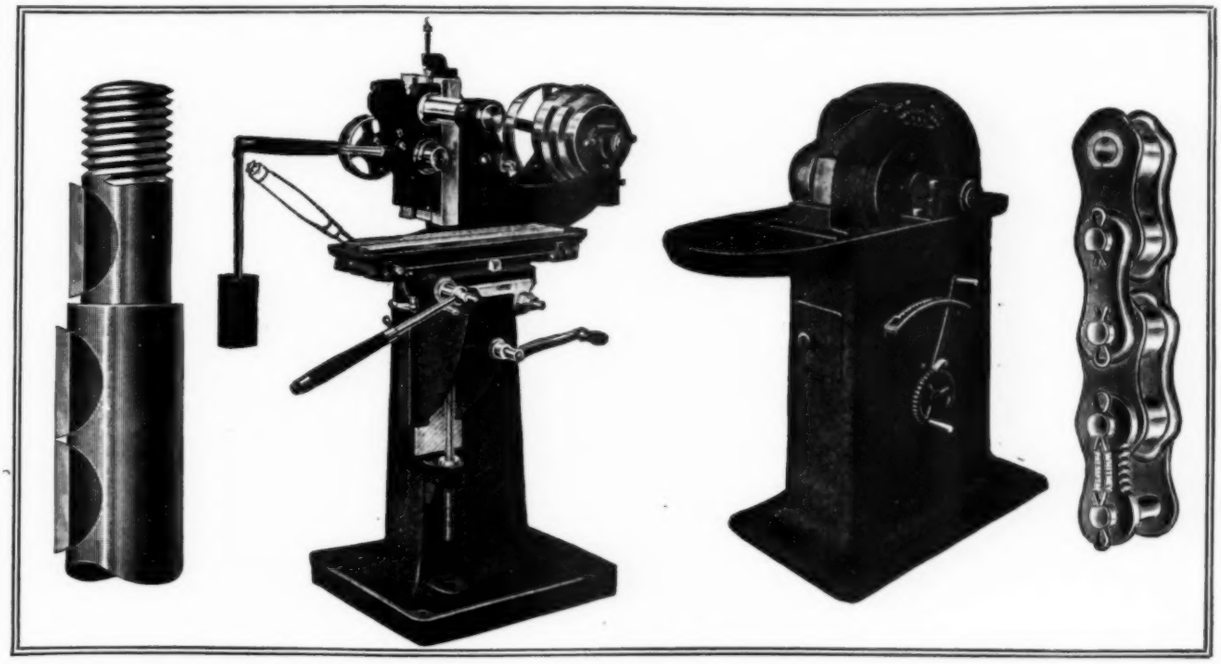


Chain Department

Roller Chains, Block Chains, Chain Belts, Quiet Chains, for Automobiles, Commercial Cars, Motorcycles, Bicycles, Machinery, etc.

Machine Department

Hand (feed) Milling Machines, 20-inch Water Tool Grinders, Keys and Cutters for the Woodruff Patent System of Keying, Presto Drill Chucks, Collets and Friction Tapping Devices.



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Ingersoll-Rand Co.....111
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Pratt & Whitney Co..3, 59 to 64
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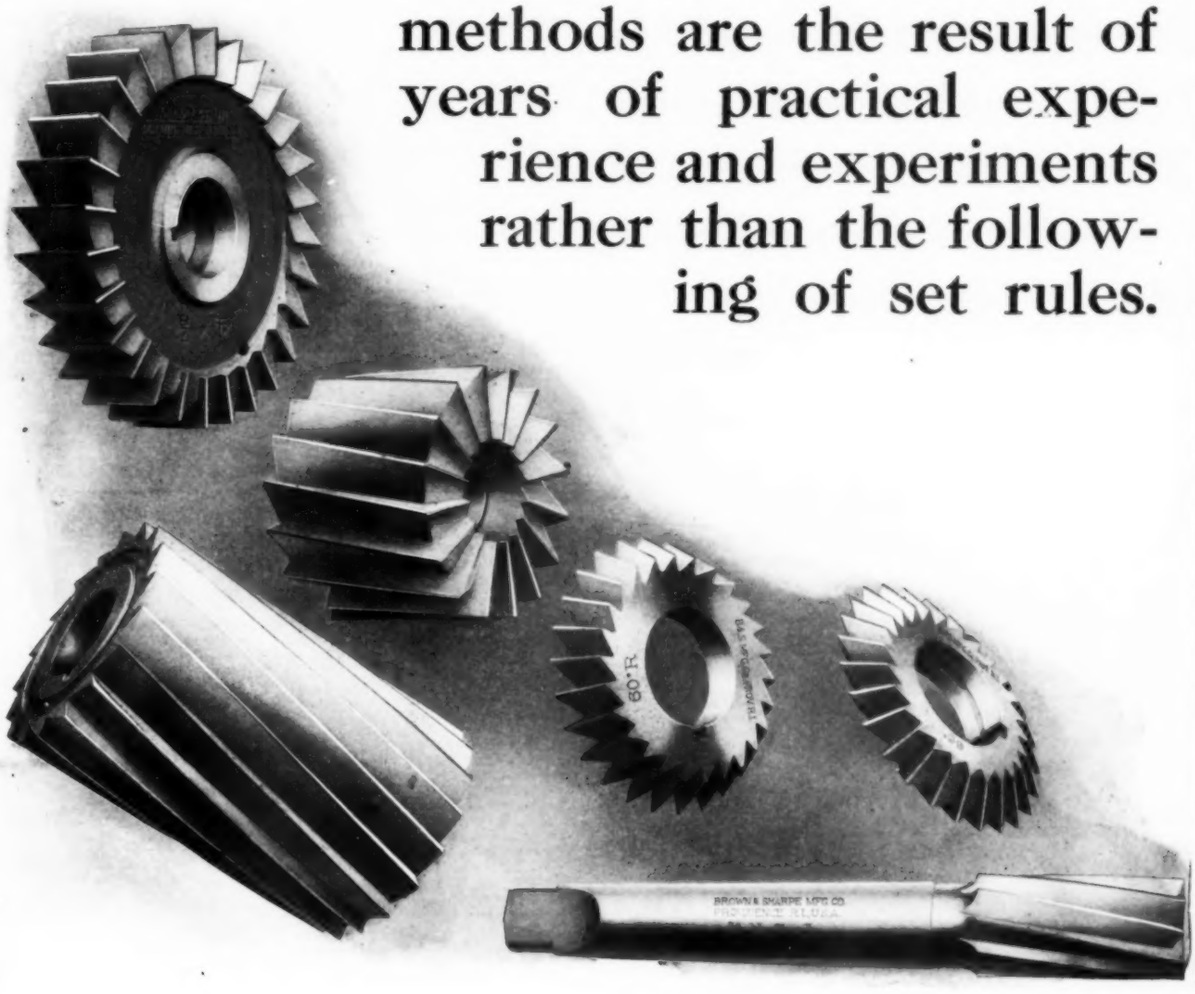
The life of a cutter depends largely upon the methods employed in the hardening.

And the successful methods are the result of years of practical experience and experiments rather than the following of set rules.



Our experience in hardening cutters during a period of over 50 years ought then to be of great value.

At any rate, the life of B. & S. Cutters, which have been subjected to severe usage in both our shops and others, have shown us that the methods we have followed are correct. It is to the results obtained by the cutter itself that we must look and to these results we invite attention.

Remember, we are cutter users as well as cutter makers.

Send for Cutter List.

Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

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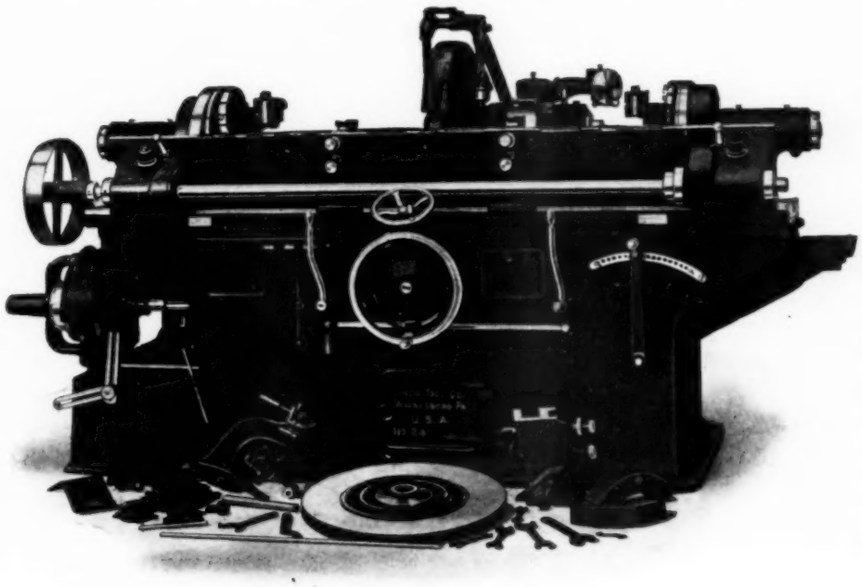
The Landis Improved Crank Grinder Produces Absolutely Round Pins



This is one very important feature about the Landis Crank Grinder—

Its ability to produce absolutely round pins.

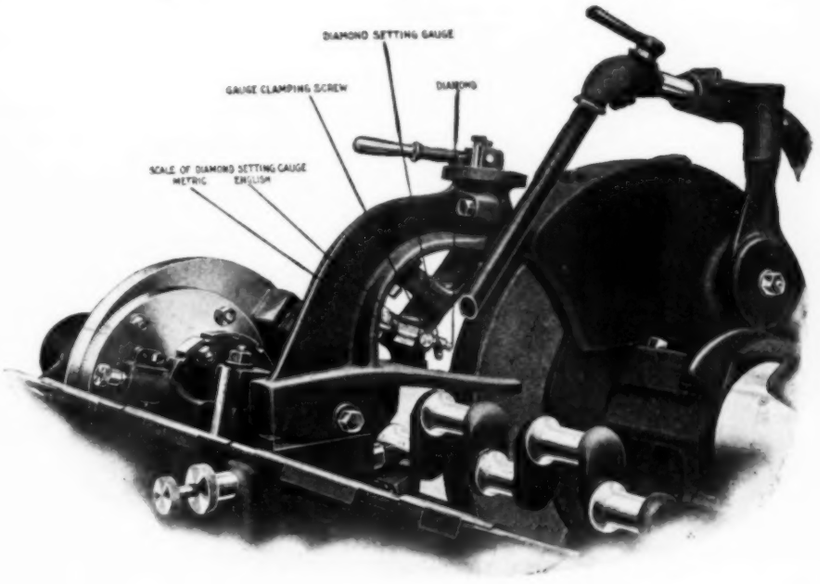
The Landis Improved Crank Grinder is designed especially for grinding and finishing crank shafts; either single or multiple throws. There are no expensive or troublesome offset centers. These are totally eliminated in the "Landis" plan of construction. The work is held by quickly operated clamping holders at both ends. Write for our complete catalog "A" and learn the full story.

You Don't Need to Remove the Work When this Truing Device is in Use

The illustration shows the radial grinding wheel truing fixture in place for use—attached to the top of one of the work rests; the lever shown on top is for oscillating the diamond when rounding the corners of the wheel for grinding fillets.

This fixture is also used for dressing the face of the wheel, and it is readily seen that the work need not be removed when it is in use. When not needed, this fixture is easily and quickly removed.

As shown, the diamond setting gauge is turned over and pushed back in its holder, where it does not interfere with the dressing operations. Let us tell you more about this and other parts which help make the "Landis" the greatest of all grinding machines.



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New York Office, Fulton Building, 50 Church Street, WALTER H. FOSTER & CO., *Managers.*

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Makers of Drills, Reamers, Cutters, Chucks, Taps, Dies, Arbors, Counterbores, Countersinks, Gauges, Machines, Mandrels, Mills, Screw Plates, Sleeves, Sockets, Taper Pins and Wrenches.

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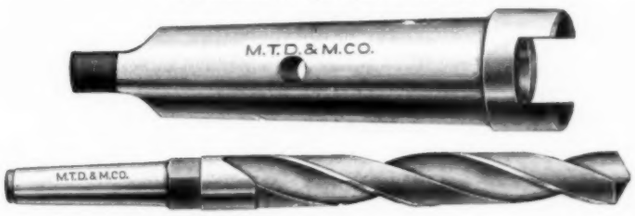
FOR MORSE TAPER SHANK DRILLS.



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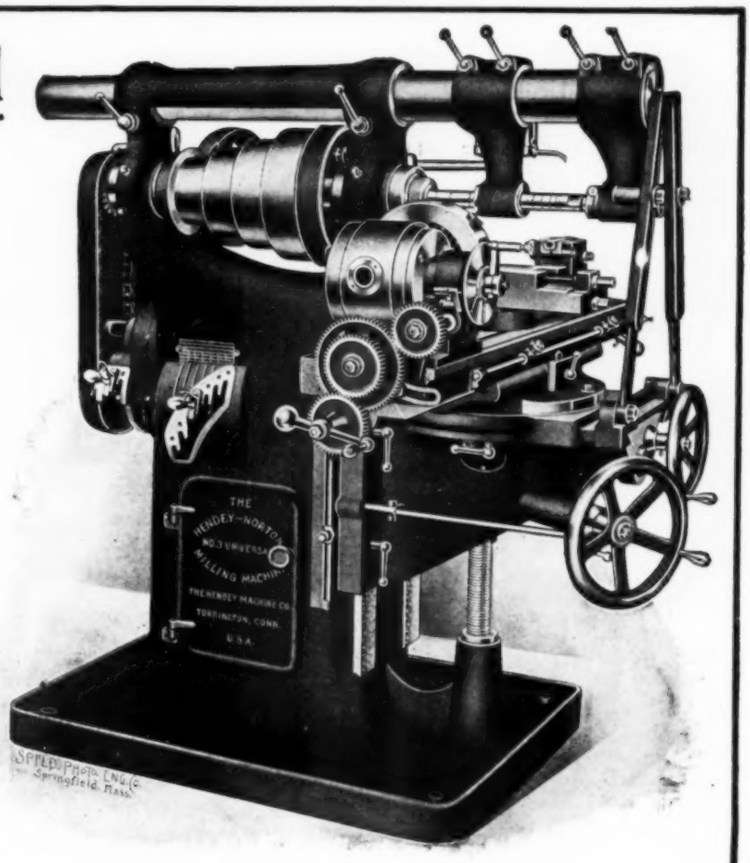
No. 3 Universal Miller



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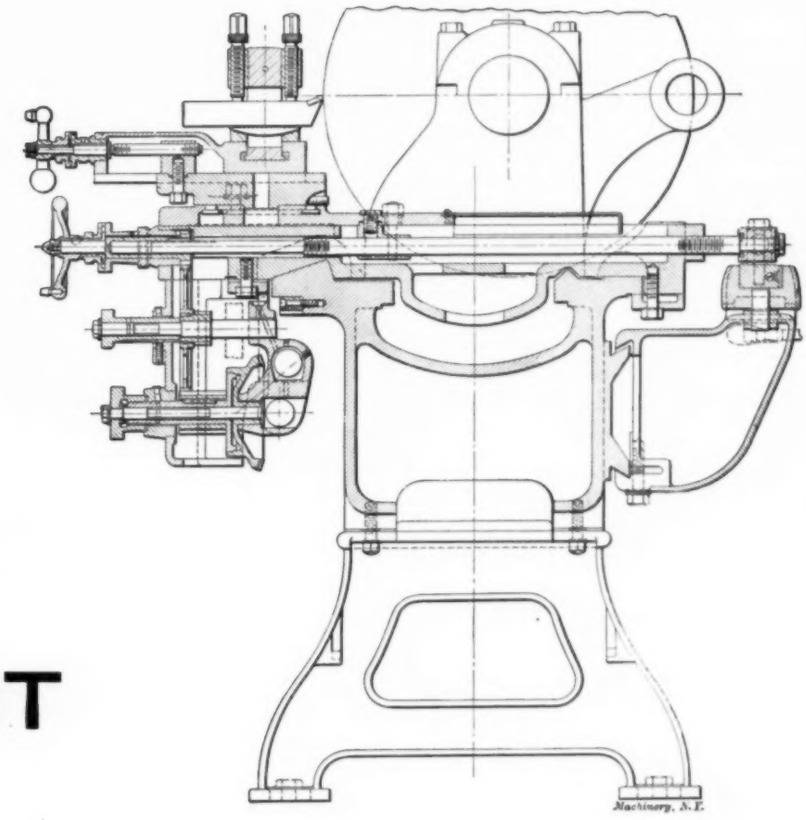

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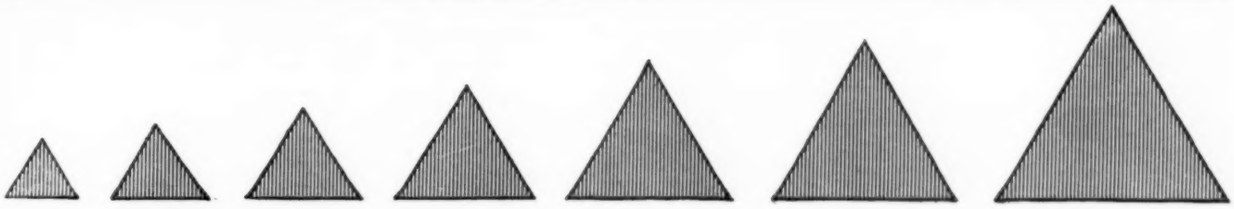

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